$9.30 06/02/12
SILICON CHIP
JAN 12
LIBRARY
NET
Top
WOODS
201001127030 020112 2
002-000-001
FAYNESVILLE MEMBAGENCY PTY LTD

SILICON CHIP

JANUARY 2012
ISSN 1030-2662
01
9 771030 266001
PRINT POST APPROVED
- PP255003/01272
$9.30* INC GST NZ$11.90 INC GST

INTRODUCTION TO ARDUINO

TV commercials too loud?
CD volume varies too much?
PA levels all over the place?
Make all these problems go away with our new

STEREO COMPRESSOR

For old time's sake:

SIMPLE AM RADIOS TO BUILD

LOW-COST PLAYBACK MODULES FOR SD CARD & USB STICK MP3s

2012 NEW YEAR, NEW PROJECTS WITH... Hardcore Electronics

JANUARY 2012

ATTENTION KIT BUILDERS

Kit Back Catalogue

If you can't find the kit you are looking for, try the Jaycar Kit Back Catalogue. Our central warehouse keeps a quantity of older and slow-moving kits that can no longer be held in stores. A list of kits can be found on our website. Just search for "kit back catalogue".

NEW KITS FOR THE NEW YEAR

G-Force Meter Kit

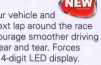
NEW

Measure the g-forces on your vehicle and it's occupants during your next lap around the race circuit, or use this kit to encourage smoother driving to save petrol and reduce wear and tear. Forces (+/- 2g) are displayed on the 4-digit LED display. Also use it to measure g-forces on a boat crashing over waves or on a theme park thrill ride. Kit includes PCB with pre-mounted SMD component, pre-programmed microcontroller and all onboard electronic components.

$49.95

- Requires 2 x AA batteries
- PCB: 100(L) x 44(W)mm

KC-5504



NOTE: We supply the PCB with the SMD component already mounted on the board to save time and frustration.

miniMaximite Controller Kit

Refer to Silicon Chip November 2011

NEW

A versatile and intelligent controller to interface with your creations, such as home automation. Features 20 configurable digital/analog I/O ports, 128K RAM and 256KB flash memory to hold your program and data. Design and test in MMBasic over a USB link from your PC, then disconnect the PC and the programs continue to operate. Alternatively, hard wire a PC monitor, keyboard, SD card reader and amplified speaker to work independent of a PC. Requires 2.3 - 3.6V DC (2 x AA or use plugpack MP-3310 $19.95). Kit supplied with PCB, pre-programmed and pre-soldered micro, and electronic components.

$49.95

- PCB: 78 x 38mm

KC-5505

NOTE: We supply all of the surface mounted components already pre-soldered to save you time and frustration.

Digital Audio Delay Kit

Refer to Silicon Chip December 2011

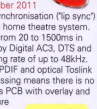
NEW

Corrects sound and picture synchronisation ("lip sync") between your modern TV and home theatre system. Features an adjustable delay from 20 to 1500ms in 10ms steps, and handles Dolby Digital AC3, DTS and linear PCM audio with sampling rate of up to 48kHz. Connections include digital S/PDIF and optical Toslink connections, and digital processing means there is no audio degradation. Kit includes PCB with overlay and pre-soldered SMD IC, enclosure with machined panels, and electronic components.

$99.95

- 9-12VDC power supply required use MP-3148 $17.95
- Universal IR remote required use AR-1729 $24.95
- PCB: 103 x 118mm

KC-5506



ARDUINO DEVELOPMENT KITS

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs (includes Jaycar stepper motors). Arduino projects can be stand-alone, or they can be communicated with software running on your computer. These Arduino development kits are 100% Arduino compatible. Designed in Australia and supported with tutorials and guides. See website for complete Arduino range.

"Eleven" Arduino-compatible Development board

An incredibly versatile programmable board for creating projects. Easily programmed using the free Arduino IDE development environment, and can be connected into your project using a variety of analog and digital inputs and outputs. Accepts expansion shields and can be interfaced with our wide range of sensor, actuator, light, and sound modules.

- ATmega328P MCU running at 16MHz
- 14 digital I/O lines (6 with PWM support)
- 8 analog inputs

$39.95

XC-4210

EtherMega, Mega sized Arduino 2560 Compatible with Ethernet

NEW

The ultimate network-connected Arduino-compatible board: combining an ATmega2560 MCU, onboard Ethernet, a USB-serial converter, a microSD card slot for storing gigabytes of web server content or data, Power-over-Ethernet support, and even an onboard switchmode voltage regulator so it can run on up to 28VDC without overheating.

- ATmega2560 MCU running at 16MHz, large Flash memory
- 10/100base-T Ethernet built in
- 54 digital I/O lines
- 16 analog inputs
- MicroSD memory card slot
- Prototyping area
- Switchmode power supply

$119.00

XC-4256

USBDroid, Arduino-compatible with USB-host Support

This special Arduino-compatible board supports the Android Open Accessory Development Kit, which is Google's official platform for designing Android accessories. Plugs straight into your Android device and communicates with it via USB. Includes a built-in phone charger.

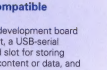
- ATmega328P MCU running at 16MHz
- USB host controller chip
- Phone charging circuit built in
- 14 digital I/O lines (6 with PWM support)
- 8 analog inputs
- MicroSD memory card slot

$69.95

XC-4222

EtherTen, Arduino-compatible with Ethernet

This Arduino-compatible development board includes onboard Ethernet, a USB-serial converter, a microSD card slot for storing gigabytes of web server content or data, and even Power-over-Ethernet support.



- ATmega328P MCU running at 16MHz
- 10/100base-T Ethernet built in
- Used as a web server, remote monitoring and control, home automation projects
- 14 digital I/O lines (6 with PWM support)
- 8 analog inputs

$69.95

XC-4216

ARDUINO MODULES

We have a huge range of simple to advanced add-ons that provide input for your Arduino projects. Visit website for more details.

Light Sensor Module

$9.95

This silicon light sensor outputs a voltage proportional to incoming light. Perfect for measuring light levels both indoors and out, security sensing and human feedback like waving a hand over the sensor.

NEW

XC-4228

Temperature Sensor Module	**XC-4230**	$16.95
Sound & Buzzer Module	**XC-4232**	$9.95
Full Colour RGB LED Module	**XC-4234**	$9.95
Microphone Sound Input Module	**XC-4236**	$9.95
Logic Level Converter Module	**XC-4238**	$6.95
Shift Register Expansion Module	**XC-4240**	$6.95
Hall Effect Magnetic & Proximity Sensor Module	**XC-4242**	$9.95
N-MOSFET Driver & Output Module	**XC-4244**	$6.95
Humidity & Temperature Sensor Module	**XC-4246**	$19.95
3-Axis Accelerometer Module	**XC-4226**	$19.95

ARDUINO SHIELDS

Range of shields and displays to add functionality to your Arduino. Visit our website for more details.

$4.45

ProtoShield Basic

A prototyping shield for the Eleven (XC-4210) and USBDroid (XC-4222). Provides plenty of space to add parts to suit any project, keeping everything neat and self-contained. Includes dedicated space to fit a power LED and supply decoupling capacitor.

NEW

XC-4214

ProtoShield Short	**XC-4248**	$4.95
Terminal Shield	**XC-4224**	$16.95
Receiver Shield 433MHz	**XC-4220**	$29.95
LCD and Keypad Shield	**XC-4218**	$29.95
Large Dot Matrix Display Panel	**XC-4250**	$39.95

Jaycar Electronics
Better, More Technical

Contents

Vol.25, No.1; January 2012 www.siliconchip.com.au

SILICON CHIP

Features

14 Arduino: What's All The Fuss About?
The low-cost, open-source Arduino microcontroller platform has taken the hobby electronics world by storm and is now gaining popularity with experienced engineers as well – by Jonathon Oxer

84 Playing USB-Stick & SD/MMC Card Music Without A PC
Do you want to play music tracks that you've saved on a USB stick or memory card without using a PC? These low-cost modules from Tenda Electronics let you do just that & even come with remote controls. Here's how to use them – by Ross Tester

Projects To Build

24 A Stereo Audio Compressor
Having problems with varying sound levels from your TV or a PA system, or when listening to music in your car? Are the soft passages too soft and the loud parts too loud? This Stereo Compressor is the answer – by John Clarke

32 Build A Simple AM Radio
This fun, educational project can be built in two forms: either shirt-pocket size or as a retro-style mantel radio in a timber cabinet. It's easy to build and the alignment is simple – by John Clarke

62 Dorji 433MHz Wireless Data Modules
Chinese-made 433MHz wireless data modules just keep getting better! Here's how to use them to make some simple data repeaters – by Stan Swan

70 3-Input Stereo Audio Switcher
Need more inputs for your stereo amplifier or home-theatre set-up? This Stereo Audio Switcher features remote control or you can just press a front-panel button to select the program source – by John Clarke & Greg Swain

Special Columns

44 Serviceman's Log
A Repeated & Puzzling Computer Failure – by the Serviceman

57 Circuit Notebook
(1) Replacement Horn Circuit For A Car; (2) Yet Another Variation On The Inclinometer; (3) Recycling A Clothes-Dryer Timer; (4) Solar Tracker Uses Two Photo-Cells; (5) Audio-Visual Metronome; (6) Wide Current-Mode 18-Bit DAC

90 Vintage Radio
The AWA PA1002 50W Valve PA Amplifier – by Rodney Champness

Departments

2 Publisher's Letter
4 Mailbag
42 Summer Showcase
79 Order Form
88 Product Showcase
98 Ask Silicon Chip
102 Notes & Errata
103 Market Centre

Stereo Audio Compressor – Page 24.

Build A Simple AM Radio – Page 32.

Dorji 433MHz Wireless Data Modules – Page 62.

3-Input Audio Selector – Page 70.

SILICON CHIP
www.siliconchip.com.au

Publisher & Editor-in-Chief
Leo Simpson, B.Bus., FAICD

Production Manager
Greg Swain, B.Sc. (Hons.)

Technical Editor
John Clarke, B.E.(Elec.)

Technical Staff
Ross Tester
Jim Rowe, B.A., B.Sc
Nicholas Vinen

Photography
Ross Tester

Reader Services
Ann Morris

Advertising Enquiries
Glyn Smith
Phone (02) 9939 3295
Mobile 0431 792 293
glyn@siliconchip.com.au

Regular Contributors
Brendan Akhurst
Rodney Champness, VK3UG
Kevin Poulter
Stan Swan
Dave Thompson

SILICON CHIP is published 12 times a year by Silicon Chip Publications Pty Ltd. ACN 003 205 490. ABN 49 003 205 490. All material is copyright ©. No part of this publication may be reproduced without the written consent of the publisher.

Printing: Hannanprint, Noble Park, Victoria.

Distribution: Network Distribution Company.

Subscription rates: $97.50 per year in Australia. For overseas rates, see the order form in this issue.

Editorial office:
Unit 1, 234 Harbord Rd,
Brookvale, NSW 2100.
Postal address: PO Box 139,
Collaroy Beach, NSW 2097.
Phone (02) 9939 3295.
Fax (02) 9939 2648.
E-mail: silicon@siliconchip.com.au

ISSN 1030-2662
Recommended and maximum price only.

Publisher's Letter

Australia's energy needs are in the hands of the clowns

I sat down to write this editorial with optimism. There was news this morning that the Minister for Resources & Energy, Martin Ferguson, was releasing the Federal Government's draft energy white paper which would set out the plan to cope with Australia's growing energy needs. The government was said to be concerned about feed-in tariffs and their effect on consumers who can't afford to install solar panels. In other words, green schemes are costing us too much.

This sounded very promising, I thought. At last the Government may be realising that its plethora of green energy schemes is very costly, causing all sorts of distortions within the economy and that Australia's ability to provide sufficient electricity at reasonable prices to consumers in the future is in serious jeopardy. So full of optimism (idiot), I decided to download the white paper – all 329 pages of it!

It is jam-packed with bureaucratese – important-sounding buzzwords and meaningless phrases; things like policy outcomes, promoting indigenous opportunities, clean energy transformation, development of regulatory settings that support increased innovation by energy retailers in terms of tariff design and consumer engagement and "a series of interconnected policy positions that collectively form the overall policy framework".

This gibberish will make it difficult for anyone who is supposed to make sensible comment. After all, it *is* open for comment and consultation until March 2012, so any stakeholder (another buzzword) who wants to make a contribution needs to respond very quickly. Just reading the document in its entirety will take many hours. I confess to scanning most of it within an hour or so.

My reaction is simply one of dismay. Can this really be the result of months or possibly years of serious consideration by public servants within the ministry for Resources & Energy? Is this the best that they can do? Are there no energy and resource specialists in the ministry w¹.o would be able to put worthwhile ideas forward? Maybe I am simply being naïve and there are no such specialists. If there are, they were not involved in the preparation of the white paper.

Well, maybe that's being too pessimistic. The white paper *does* contain significant amounts of relevant information, contributed by such bodies as the Australian Bureau of Agricultural & Resource Economics & Sciences, the Productivity Commission (which the Government seems to consistently ignore), Geoscience Australia, the ministry's own Bureau of Resources & Energy Economics, the International Energy Agency and not forgetting the Department of Climate Change and Energy Efficiency! Nor should I forget to mention inclusions from the Treasury's esteemed paper entitled "Strong growth, low pollution: modelling a carbon price" (2011).

Mind you, the Treasury paper on the carbon price is highly tendentious to say the least, and mostly in the realm of fantasy, as a more brutal assessment. And the Department of Climate Change and Energy Efficiency must be contemplating an uncertain future after the next federal election, given the stated intentions of the Federal Opposition and the recent decisions by the Canadian government to disband their equivalent department and to formally opt of the Kyoto Protocol.

In the meantime, if the much-vaunted white paper is anything to go by, energy policy in Australia is in a mess. There is no plan. It is merely a series of observations and platitudes. And yet, energy policy in Australia could be so good. We are a very rich country. We are one of the biggest energy exporters in the world (via coal, uranium and gas).

Let us hope that the next government can put things right.

Leo Simpson

Integrate Touch Sensing Quickly and Easily

With Microchip's Range of Low Power, Low Cost Solutions

Microchip's mTouch™ Sensing Solutions allow designers to integrate touch sensing with application code in a single microcontroller, reducing total system cost.

Microchip Technology offers a broad portfolio of low power, low cost & flexible solutions for keys/sliders and touch screen controllers. Get to market faster using our easy GUI-based tools, free source code and low-cost development tools.

Capacitive Touch Keys and Sliders

- Extend battery life with eXtreme Low Power MCUs
  - Proximity sensing in less than 1 µA
- High noise immunity and low emissions
- Broad portfolio of MCUs lowers system cost
  - 8, 16 & 32-bit PIC® MCUs for Capacitive Touch
  - Integrated USB, Graphics, LCD, IrDA®, CAN,
  - No external components
- With **Metal Over Cap technology** you can:
  - Use polished or brushed metal surfaces including stainless steel and aluminum
  - Sense through gloves
  - Create waterproof designs
  - Deploy Braille-friendly interfaces

Touch Screen Controllers

- Fully processed touch coordinates
- **Projected Capacitive technology**
  - Multi-touch enabling gestures
  - Low cost MCU implementation
  - Wide operating voltage: 1.8-5.5V
  - Low operating current 1.5 mA at 5V typical
- **Analog Resistive technology**
  - Lowest system cost, easy integration
  - Universal 4, 5 & 8-wire solution with on-chip calibration
  - I²C™, SPI, UART or USB interfaces
  - Low power "touch to wake-up" feature

GET STARTED IN 3 EASY STEPS

- Visit **www.microchip.com/mtouch**
- Download App Notes & royalty-free source code
- Order a development tool

Enhanced mTouch Capacitive Evaluation Kit (DM183026-2) (For keys & sliders)

Projected Capacitive Development Kit (DM160211)

Analog Resistive Touch Screen Development Kit (DV102011)

Microchip Technology Australia
Tel: (02) 9868 6733 E-mail: aust_nz.inquiry@microchip.com

microchip DIRECT
www.microchipdirect.com

www.microchip.com/mtouch

MICROCHIP

The Microchip name and logo, the Microchip logo and PIC are registered trademarks, mTouch is trademark of Microchip Technology Incorporated in the USA and other countries. All other trademarks mentioned herein are property of their respective companies.
© 2013, Microchip Technology Incorporated. All rights reserved.

MAILBAG

Letters and emails should contain complete name, address and daytime phone number. Letters to the Editor are submitted on the condition that Silicon Chip Publications Pty Ltd may edit and has the right to reproduce in electronic form and communicate these letters. This also applies to submissions to "Ask SILICON CHIP" and "Circuit Notebook".

When will road tunnels get DAB+ reception?

I have just read your Publisher's Letter in the October 2011 issue. I feel absolutely vindicated that someone of authority has finally spoken up about the poor reception problems with DAB+; so much so that when I read the fifth paragraph, it was as though I was reading my Mailbag letter from August 2010. I hope it finally silences my critics.

To use a really bad choice of words, DAB+ is OK in a "*static*" environment but poor on the move.

Another point, how are the radio authorities planning on getting DAB+ to work in tunnels? It has been more than two years since the official launch of DAB+ and there is no reception in any tunnel in Sydney.

Simon Kareh,
Penshurst, NSW.

Rising electricity tariffs are the problem

With regard to your article "Can You Really Reduce Your Electricity Bill" in the September 2011 issue, I find it important to say that reducing one's electricity bill is impossible to do. Well maybe in the short term yes – however, get enough people to reduce their electricity bill, or better reduce their electricity consumption, and the electricity tariff will go up and we are then back to where we were.

I find all this talk about "Reducing Your Electricity Bill" as either misleading or even false advertising. People are being "lulled" into buying new gear and gadgets to attempt reducing their electricity bill. So what we are really doing is putting more pollution into our environment by producing and selling all this "useless" gear (your comment as well).

I would have less objection if your article was entitled "Can You Really Reduce Your Electricity Consumption" but then again who would read it if the mighty dollar was not involved.

If we *really* want to reduce the electricity bill then there has to be legislation to stop tariff hikes!

Werner Hahling,
Townsville, Qld.

High mains voltage kills halogen lamps

The Publisher's Letter in the December 2011 issue, on the stability of the electricity grid, is timely and relevant to my recent experience with light bulbs.

I recently installed a strip of six spotlights using Sylvania HiSpot ES50 50W GU10 halogen lamps. Imagine my disappointment when five of the six burnt out within a few hundred hours of use! The local Sylvania representative was surprised but offered to replace the lamps. He added that it was possible that the reason the lamps had failed could be due to large fluctuations in mains voltage. He said that while these lamps are rated at 240VAC, their life is halved by as little as a 5% increase in the mains voltage. I did a spot check of the mains voltage and found a reading of 252V on both an analog multimeter (AVO Mk.8) and a digital multimeter.

When I checked the Sylvania website I was even more surprised to find that in fact these bulbs were rated for 230VAC, not 240V, so they were actually running at 10% above their rated voltage. Any surges above this could be the straw that broke the camel's back. Of course, I had no way of knowing whether there might be occasional surges that were considerably higher, perhaps due to "feed in" from nearby solar panels.

Interestingly, some other manufacturers of GU10 halogen lamps rate their products at 260VAC, something that I had never seen before. Perhaps the margin of voltage tolerance for these lamps is very small.

There seemed to be little point in replacing the Sylvania bulbs with the same type because the same thing was likely to happen again. Accordingly, I started to think about replacing them

Grid protection requirements set the voltage limits

No doubt you would have had many responses to your Publisher's Letter in the December 2011 issue, in regard to inverters and connection to the mains. You need to have a look at AS4777.3 grid protection requirements.

Section 5 covers Grid Protection Requirements. In particular, 5.1 (b) covers voltage requirements – All inverters connected to the grid must have under /over voltage protection as well as under/over frequency protection.

The inverters that we use in our micro-turbine applications have programmable protection relays which we must set during commissioning (password protected) to the limits given by the utility: voltage typically ±6% or 10%; frequency typically ±0.5 Hz with a time setting of 0.09 seconds.

Mike Abrams,
Capalaba, Qld.

Comment: if the mains voltage is nominally 230VAC and is allowed to increase by 10% before a grid-connect inverter will disconnect, that means that the mains voltage in a street where a lot of houses have solar panels can rise to 253V. In fact, the maximum specified trip point is 255V.

Add in the effect of spikes and other local disturbances and there is plenty of potential to damage electronic equipment. This is precisely what the electricity distributors are concerned about.

AS9120A Certified Distributor

au.mouser.com
Distributing semiconductors and electronic components for design engineers.

Authorized Distributor

Find It Here. Faster.

The Newest Products for Your Newest Designs®

- Global Authorized Distributor of Electronic Components
- 450+ Industry-Leading Suppliers
- No Minimum Order and Same-Day Shipping
- World-Class Local Language Technical Support
- 17 Website Languages and Currencies Available
- 2 Million Parts Online

au.mouser.com | australia@mouser.com

Active Components
+61 (2) 9893-9400 (New South Wales)
+61 (3) 9775-4778 (Victoria)
+64 (9) 443-9500 (Auckland)
+64 (3) 355-4545 (Christchurch)
+64 (4) 915-9500 (Wellington)
mouser@activecomponents.com
www.activecomponents.com

X-ON Electronic Services
+61 (7) 3394-4490 (Brisbane)
+61 (3) 9574-9044 (Melbourne)
+61 (8) 9358-9358 (Perth)
+61 (2) 9748-7622 (Sydney)
mouser@x-on.com.au
www.x-on.com.au

MOUSER ELECTRONICS
a tti company

Mouser and Mouser Electronics are registered trademarks of Mouser Electronics, Inc. Other products, logos, and company names mentioned herein, may be trademarks of their respective owners.

Microbee computer resurrection

Microbee Technology Pty Ltd is proud to announce the launch of its brand new website and pre-release details of the Premium Plus kit computer. Launched on Sunday 27th November, the website has details on the company history and chain of ownership, from Applied Technology to Microbee Systems Ltd, Microcorp, Metrocomp & Microbee Technology Pty Ltd and how it all fits together.

There is also a page dedicated to pre-release information of the Premium Plus kit computer. Although the model is not ready for release as yet and the final product & software may change, the details show where we are at and what we are aiming to release.

I am very excited about this new kit bee as it is a good combination of old and new. We have put a lot of work in to get it to this stage with a complete new coreboard design, newly sourced keyswitches and custom made key tops and key switch frame.

Originally it was a target to have released the new machine by now but during the design process it was found that with a few minor changes in the architecture a full dual processor design could be realised and a much better offering for the software path could be achieved.

Our aim now is to have the Premium Plus for release in February 2012 to coincide with the 30th anniversary of the release of the original 16k kit Microbee. Be sure to check out the old models/gallery page as well.

Ewan J. Wordsworth,
Microbee Technology Pty Ltd.
http://www.microbeetechnology.com.au/

with LED lamps. After searching the web, I settled on Verbatim GU10 LED lamps (8W, 2700K warm white). At about $44 a pop, they were not exactly cheap but with a claimed life of something like 30,000 hours, the price seemed justified. The results were excellent, with a pleasant light quality of comparable intensity to the 50W halogen lamps. Since the LEDs do not have filaments, I expect that they will be less prone to damage by voltage surges.

Inspired by this success, my thoughts turned to another part of the house where there are some "compact fluoro" lamps on very high ceilings. Knowing that one of the commonest causes of severe injury to males of a certain age is falling off ladders, I decided to replace the compact fluoros with LED lamps. At least I would not have to climb up to replace them very often.

The compact fluoro ceiling lamps were recessed into the ceiling in metal cans with Edison screw fittings. The only suitable ES LEDs that I could find were 8W Verbatim R63 2700K, at a similar price to the Verbatim GU10 LEDs. These lamps have an elongated lily-shaped housing made up of thick metal "petals".

Soon after I installed the recessed ceiling ES LEDs, one started flickering wildly and then conked out. Upon unscrewing the LED I was surprised to feel how hot it was. After a moment's reflection I realised that the metal petals were an essential heatsink and not merely decorative; but heatsinks cannot work if there is no air circulation. This is exactly the situation if the lamp is in a closed inverted metal can recessed into the ceiling!

Was the failure of the LED due to overheating? I allowed the lamp to cool and tried it again. It produced light immediately, so it was not permanently damaged but after a few minutes it flickered and conked out once again. While I have no proof, I am reasonably sure that the fundamental problem was overheating due to lack of air circulation around the heatsink.

Apparently, the inbuilt switching power sources in 240VAC LED lamps contain electrolytic capacitors and even if the lamp does not fail immediately, prolonged high temperature is likely to result in drastic shortening of their life. If my logic is correct, it would seem that LED lamps should not be used in closed inverted recessed metal holders. Reluctantly, I replaced the previous compact fluoro ceiling lamps and will call an electrician when they need replacing.

The GU10 LED spot lamps should be OK because they are fully exposed and have plenty of air circulation around them but I would suggest that GU10 LEDs should not be used in closed fittings where there is no air circulation.

James Goding, VK3DM,
Princes Hill, Vic.

Comment: CFLs probably present an even bigger problem with their susceptibility to higher than normal mains voltages and also their requirement for adequate ventilation. Putting a CFL in an enclosed oyster fitting is a sure recipe for a very short life. LED fittings should be an improvement but ventilation is very important.

Mandating technological improvements in cars

I have been listening to recent news media where Victorian Police have been despairing about the crazy things that drivers are doing and causing preventable deaths on the roads we all share. For many years, I have held the view that the only way to significantly reduce or even perhaps eliminate the road toll is to take away a driver's ability to make "serious errors".

This technology has long existed in aircraft – particularly with Airbus aircraft which will simply not allow a pilot to fly outside a jet's safe limits for airspeed, bank angle etc. An example of this occurred in January 2009 with US Airways Flight 1549. An Airbus A320's flight computer worked with Captain Sullenberger to keep the plane's pitch at optimum angles to prevent the plane from stalling before it landed safely in New York's Hudson River. Later flight analysis showed that the computer did make subtle flight corrections to increase forward air speed during the decent. Had the plane stalled there would have been a catastrophic loss of life.

This technology is already used in "S" class Mercedes cars mainly for safe cruise control but I feel the technology

could be economically extended to reduce the road toll by:

- Government legislating that all new cars be fitted with forward looking sonar/radar/image analysis that calculates and senses imminent danger and takes corrective action much faster than a human can ever react.
- Fitting highly accurate GPS and transponders that broadcast a vehicle's type, length, speed and GPS location to other nearby vehicles – similar to an aircraft TCAS system.
- If a car ahead has come to grief it can transmit a distress call to all other nearby cars, avoiding the possibility of a "pile up" in poor visibility conditions. It can also call in emergency services if (for example) an airbag has been deployed.
- Stop unlicensed driving by incorporating a "chip" into all driver licenses which must be inserted along with the ignition key. Unlicensed driving appears to be a significant problem in Australia.
- "G" force detection; if a vehicle is being driven highly erratically the car's computer can decide to disable or reduce engine power – depending on the experience of the driver license used.
- Use biometric sensors to help prevent a borrowed license being used. Decent sensors can detect a fingerprint.
- Have vehicles log the driver's speed, etc on their license chip for a defined period of time – which can be audited by police during a roadside check. This in itself is a deterrent to hoons.
- Automatically enforce speed limits

Clarification of frequency bands

I would like to thank Ron Rye from Heidelberg, Vic (Mailbag, December 2011) for pointing out the "AM" groundwave propagation versus line of sight properties of VHF/UHF. However, it is a pet peeve of mine when people refer to the broadcast bands as AM and FM.

As most readers are aware, the terms AM (Amplitude Modulation) and FM (Frequency Modulation) only refer to the way the audio signal is imposed on the RF carrier frequency. The AM broadcast band is MF/MW, depending on if you are referring to it as frequency (Medium Frequency) or in wavelength (Medium Wave).

Many old receivers also have SW (shortwave) or HF (high-frequency) reception. Again, it is the same thing and such sets have MW printed on the dial as distinct from the SW band which is also amplitude-modulated. Most people are also aware that the FM broadcast band is VHF (Very High Frequency) which prior to being used for radio in Australia was VHF Band 2 for TV broadcasting.

I realise these are only technicalities but I do think it's worthy of mention if propagation and coverage is brought into the argument, as the radio frequency has the bearing on the propagation not the type of modulation.

David Alford,
Shepparton,Vic.

Earthing of solar panel installations

I have a couple of comments on the letter by Bruce Pierson in the Mailbag pages of the November 2011 issue. With respect to earthing of the solar panels, Bruce states that the only earthing is through an earth stake near his house. This is not correct as the Earth is bonded to the Neutral at the switchboard; the Neutral is connected to the Neutral of the incoming mains, the same Neutral that is connected to most of the other dwellings in his street.

These Neutrals are also bonded to Earth and connected to earth stakes at each switchboard, as is the Neutral bonded to Earth at the domestic supply transformer. One may argue about I^2R losses, line impedances and voltage drops but these "new" earth stakes are in parallel and their effect on the whole circuit would be significant.

If lightning strikes were the main concern then the solar panels should be isolated from the roof and frame as there would be no potential difference between the solar cells and the atmospheric conditions. Lightning wouldn't strike the solar cells but the roof instead and current would pass through the roof and frame to ground, bypassing the solar cells as there is no complete electrical circuit through them to ground.

Unfortunately, lightning should not be your major concern but rather a fault developing in the solar cell and DC side of the inverter circuit that allows a path to ground (earth). This fault may not be detected or realised until personnel get up on the roof to do maintenance and complete the fault circuit by being in contact with both ground (via the roof) and the faulty circuit, leading to a nasty shock or much worse.

The chances of a lightning strike directly hitting your roof is very remote. With most reported house lightning strikes the lightning actually strikes the power lines running down the street and the surge in voltage causes large currents to flow into the house wiring seeking a path to ground (earth). The main reasons for this are that power lines are generally higher than roofs and the physical profile of a power line cable as seen by lightning is more inviting than a reasonably flat structure like a roof.

As an aside, the towers and aerials that stand guard around structures like electricity sub-stations and explosive magazines don't have as their primary function the ability to divert lightning strikes from the area or compound. Their main function is to bleed electrons back into the atmosphere and because lightning is a result of an electrostatic charge build-up, not a continuous current device like an alternator, the potential difference and/or voltage gradient between the clouds and ground is reduced, thus making a lightning strike in that area much less likely.

Of course, if that fails and a lightning strike occurs, then their secondary function is to divert and withstand the current generated, thus protecting the other structures.

Rather than beefing up his earth stake(s), Bruce would be well advised, if he is in a lightning-prone area or just to be sure to be sure, to install a lightning or surge-diverter in his switchboard. These are usually connected after the main switch next to the circuit-breakers and will suddenly go from non-conducting to heavily conducting to Earth when a high-voltage transient occurs on the incoming mains.

Trevor Krause,
Gympie, Qld.

in defined dangerous/known accident prone areas, sharp corners, near schools, etc.

I would be cautious about overtaking limitations applied on open single-lane highway situations where you need everything to pass a long truck quickly. However, such restrictions could be applied by the type of license and experience the driver has. A red "P" plater could have different restrictions to someone with say 10 years' experience. The vehicle would know it is in proximity of a large truck either by its own sensors or the truck's transponder and also calculate the needed overtake speed by also looking out for any transponders on approaching vehicles. A warning could sound if the approaching vehicle does not have a transponder fitted.

If legislated, police would no longer need to have high-speed pursuits – they would simply send an encrypted satellite signal to the offending vehicle to disable or slow it as needed. Hence joy-riding would be eliminated and vehicle theft in general reduced. I realise professional thieves still tow away selected cars – but properly integrated computer systems could render their "loot" useless if they attempted module swaps that are not digitally assigned to that specific vehicle.

Of course, there would be those who would argue that new car sales would suffer at the thought of having to pay extra to have restrictions applied. But most of us do abide by the road rules and Governments can offset this by handing out incentives like tax breaks and comprehensive insurance reductions to offset added production costs.

If you think about how much all levels of government are paying out each year (and hence tax payers) in traffic accident and medical rehabilitation insurance claims, reducing these costs would easily fund these incentives.

There would also be those who would claim that such a system would create "underground jail break" businesses with modifications to defeat the system. If the system were properly designed and incorporated into a vehicle's engine management system so that only certified dealers had the means to update firmware this problem could be eliminated, especially if the firmware also carried the digital signature of the dealer that changed it.

I appreciate that this solution may take a long time to implement but I would argue that it would not add excessively to the cost of new vehicles in mass production, particularly in contrast to the cost of loved ones lost forever.

If the Federal Government made

this an Australian Design Rule, the mass-production of such technology on both local and imported vehicles should be a viable solution. Perhaps someone reading this may have the influence to at least get the political debate started.

Michael Tobin,
Endeavour Hills, Vic.

Comment: we are all for technological advances in motor vehicles but definitely not keen on government mandating that such technology must be incorporated into all new vehicles. Besides, while technology in cars has advanced rapidly in the past two decades, much of our road network is woefully inadequate and undoubtedly is the cause of many accidents.

Hammond organ restoration project

I have a 1950s vintage Hammond organ that is suitable for restoration. It was intended as a retirement project. However, since retiring I have discovered an unending stream of other distractions and have realised that I will never get around to this one. So it is offered free to a good home.

The only catch is that it would have to be collected from my home in Canberra. The organ is an A-100 console model S/N 17320, which is apparently the same as a C-3 model with two manuals and a full pedal keyboard. I have the stool that goes with it. I also have a service manual that I obtained a few years ago that covers a number of models including this one.

Some years ago I cleaned up the two power amplifier chassis (main and reverb) and tested them. They have their full complement of valves. The organ has no speakers, however modern 12-inch units should be easy to fit. The woodwork will also require some attention.

Anyone interested in taking on what should be a very interesting project can contact me at **panddc@grapevine.com.au**

Peter Churchill, Kambah, ACT.
Phone: (02) 6231 6031.

Another energy saving scam but on a bigger scale

I would like to bring your attention to another energy saving scam at **http://www.ultraenergy.com.au**

They have clever marketing to large companies to ensure they don't sell to people like you who could disprove their claims. The patent and website are worth a laugh to your older engineers but it is unfortunately bamboozling enough to fool enough engineers to probably make it profitable. Some of my younger engineering colleagues weren't sure whether it was for real and asked my opinion.

Unfortunately, with companies striving for cost reductions, older engineers are being replaced with cheaper, younger ones and most of the engineering is outsourced. I was the Technical Authority for a large oil company until a year ago, responsible for all the electrical, instrument and control engineering for their fuel terminals (tank farms). After I left, the remaining three electrical guys, who are now my friends, are all under 35.

They emailed me for advice after the salesman tried to sell them this system, which ranges from $4000 to $70,000. They weren't sure it was for real but were tempted because the salesman said another oil company had installed one and saved 15%. The oil company (my previous employer) has a heap of retail outlets and are always looking to save power but it is usually the junior engineers that are assigned the job of finding energy saving devices and often they would trial them without seeking head office approval from the Technical Authority.

I found that many of the regional areas were taken advantage of by all sorts of predators; without local engineering expertise they had no idea they were being ripped off. Because of the widespread outsourcing, the remaining staff are always overloaded and would not likely seek advice from their consultants on a small matter like this.

It looks like this company is installing these systems but being sure it, and not a third party, prepares the report on the energy savings after the system has been in for a year; as long as the

Kinsten Presensitized PCB & associated products

IN STOCK NOW!

- Single Sided Presensitized PCBs
- Double Sided Presensitized PCBs
- Fibreglass & Phenolic
- UV Light Boxes
- DP50 Developer
- PCB Etch Tanks, Heaters & Aerator Pumps
- Thermometers
- Ammonium Persulphate Etchant
- PCB Drill Bits (HSS & Tungsten)

WILTRONICS
36 Years Quality Service

For full range, pricing and to buy now online, visit
www.wiltronics.com.au
Ph: (03) 5334 2513 Email: sales@wiltronics.com.au

Mailbag: continued

SCR crowbar could offer enhanced loudspeaker protection

I wish to offer some thoughts regarding the Loudspeaker Protector project in the October 2011 issue. I feel the effectiveness of this circuit could be improved with crowbar protection, utilising a couple of SCRs. Such a protection system is used in some commercial amplifiers and one of the reasons may be that quality relays are expensive and getting more expensive.

In some power amplifier designs, special (and expensive) relays are used which have two sets of contacts. One contact is heavy duty tungsten and the other is gold. The gold contact closes after the tungsten contact has fully closed, thereby ensuring very low and stable contact resistance at tolerable cost.

In the crowbar protection system I propose, each SCR is connected from one rail to ground after the respective rail fuse (and therefore, before connection of the supply to the amplifier). This arrangement is much superior to using a single Triac, not least because a Triac will be open-circuit (relative to the supply) as soon as one of the two rail fuses has blown, with the possibility that one rail will remain connected to the amplifier if only one of the two fuses blows, with disastrous results if that happens to be the rail feeding a failing or already shorted output transistor.

Other issues to take into account are that a relay in series with the speaker system can affect frequency response because of variable contact resistance, while imperfect and varying contact may also result in distortion. Relay contact resistance does vary through oxidation/tarnishing and arcing/pitting, and probably also due to vibration.

Perhaps a relay in parallel with the speaker just to prevent switch-on thump (ie, the relay is closed at switch-on and opens as soon the supplies stabilise) may be a better option. A relatively low resistance in series with the relay (say, 2Ω or so, with the series combination of relay and resistor in parallel with the speaker) would ensure that most of the switch-on thump current passes through the relay and this current will only flow momentarily while the supplies stabilise.

Any resulting switch-on thump will be much quieter and the speaker would be directly connected to the amplifier very soon after switch-on. I doubt that there would be any issues with output transistor SOA being damagingly exceeded under such circumstances. If such an arrangement were used, a shunt shorting relay from the amplifier input to common/ground would block input signal until the supplies stabilise.

Another advantage of the electronic crowbar protection scheme is virtually instantaneous operation. This can save expensive output transistors. I feel that there are so many advantages to electronic crowbar protection systems for power amplifiers that SILICON CHIP should at least consider at least experimenting with such a system.

Otto S. Hoolhorst,
Brisbane, Qld.

customer thinks they are saving money and doesn't sue, there is no problem. Of course, even if the system was found to be a fraud, the engineer that approved it would not want to reveal that to management, for fear of looking foolish or losing their job. Regardless, Ultra Energy would already have been paid years earlier and forgotten about. Of course, residential customers are easy prey, since electricity is just magic to the common person.

I think the only real solution is education and enlightenment via magazines such as yours, to at least sow the seed of doubt. It would be nice if fraud was a crime and companies like this were pursued by the government.

Duncan Quick,
Altona, Vic.

Comment: you really do have to wonder whether there would be enough gullible corporate customers out there. These days a lot of companies are having audits of their energy use and making vary careful decisions about energy saving. But if, as you say, only junior engineers are making the decisions, they can be scammed.

Interestingly, for someone who is technically knowledgeable, the FAQs on the Ultra Energy site tell the story. The Ultra addition isn't a capacitor; it is an open circuit. It doesn't modify the voltage, it somehow "optimises the conductivity within the circuit." Well, presumably that means that it can't actually reduce the power consumption.

The method of showing savings is interesting too. They compare consumption from period to period – which is misleading. It also seems to indicate that simply connecting the Ultra across the mains will have no measurable effect! In stating that, they do not realise that the only logical conclusion is that it must have no effect on energy usage, as well.

Galloping technology can make extended warranties not worthwhile

I read the Publisher's Letter in the November 2011 issue and have a few comments to add. Quite often buyers are not aware of extended warranty terms and conditions.

For example, in most extended warranties, the insurance company states they have a right to replace the product with a compatible product, even though the insured value could be far more than the market value. Given the pace that technology is progressing and the price of a new product model being cheaper than a former product model, in the event that an item under insurance is not repairable or cost more for a repair, the insurance company could replace the insured product model with a new model.

If the owner decides not to take the replacement product model, the replacement cost which is payable is usually far less than the actual insured amount, given the price of a new product model.

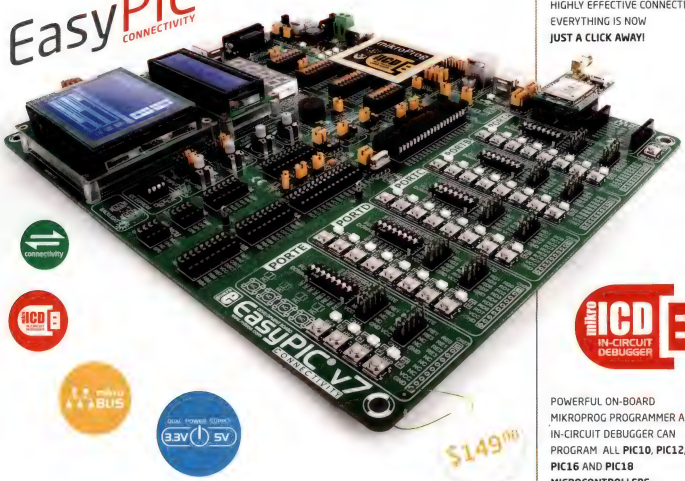
The other factor is that quite often a lot of buyers are not aware that they are buying the extended warranty from an independent insurance company and not the shop from which they

IT'S HERE!

mikro BUS

JUST PLUG IN ONE OF YOUR **CLICK BOARD™** AND IT'S READY TO WORK. SPECIALIZED **MIKROBUS™ COMMUNICATION INTERFACE** MAKES YOUR DEVELOPMENT EASIER, AND ALLOWS SIMPLE, YET HIGHLY EFFECTIVE CONNECTIVITY. EVERYTHING IS NOW **JUST A CLICK AWAY!**

EasyPIC v7 CONNECTIVITY



connectivity

mikro ICD IN-CIRCUIT DEBUGGER

mikro BUS

DUAL POWER SUPPLY 3.3V 5V

$149.00

POWERFUL ON-BOARD MIKROPROG PROGRAMMER AND IN-CIRCUIT DEBUGGER CAN PROGRAM ALL **PIC10**, **PIC12**, **PIC16** AND **PIC18 MICROCONTROLLERS**. OUTSTANDING PERFORMANCE AND EASY OPERATION WILL BLOW YOUR MIND. YOU WILL NEED IT, WHETHER YOU ARE A PROFESSIONAL OR A BEGINNER.

Best selling PIC development board in the world enters it's 7th generation of development. It is state of the art in design, functionality and quality. With 4 connectors for each port EasyPIC v7 has **amazing connectivity**. Ports are logically grouped with their corresponding LEDs and Buttons. Powerful on-board **mikroProg** In-Circuit Debugger and programmer supports over 250, both **3.3V and 5V devices**. Three types of displays, Serial EEPROM, two temperature sensors, Piezo Buzzer, USB connector, RS-232 and FTDI, Oscilloscope GND pins, as well as **mikroBus support** make this board an irreplaceable PIC development station.

DUAL POWER SUPPLY

3.3V 5V

EASYPIC V7 IS THE ONLY DEVELOPMENT BOARD IN THE WORLD TO SUPPORT BOTH 3.3V AND 5V MICROCONTROLLERS. REVOLUTIONARY ENGINEERING ALLOWED US TO SUPPORT **OVER 250 MICROCONTROLLERS** IN A SINGLE BOARD. IT'S LIKE HAVING TWO BOARDS INSTEAD OF ONE!

MikroElektronika
DEVELOPMENT TOOLS | COMPILERS | BOOKS

GET IT NOW
www.mikroe.com

Is your hip-pocket nerve hurting?

We know how you feel – prices seem to be going up all the time.

But you can save money by taking out a SILICON CHIP subscription.

A 12-month subscription will get you 12 issues for the price of less than 11!

For an even bigger discount, a 2-year subscription gets you 24 issues for the price of 20!

Best of all, a 2-year subscription gives you longer protection against future price rises.

Count the advantages:

1. It's cheaper – you $ave money!
2. It's delivered right to your mail box!!
3. You can always be sure you'll receive it!!!
4. We pick up all the postage and handling charges!!!!
5. You will never miss an issue because it's sold out (or you forgot)!!!!!

PLACE YOUR ORDER NOW AND START $AVING!

Please tick box required

☐ **6 MONTHS *SILICON CHIP*** ($52.00)

☐ **12 MONTHS *SILICON CHIP*** ($97.50)..... ☐ **OR WITH BINDER** ($115.00)

☐ **24 MONTHS *SILICON CHIP*: ($188.00)**..... ☐ **WITH 2 BINDERS** ($222.00)

Your Name_____ **Address**_____

_____ **Postcode**_____ **Daytime Phone No. (** **)**_____ **Email address** _____

Method of Payment: ☐ EFT (ring or email for details) ☐ Cheque/Money Order ☐ PayPal ☐ Visa Card ☐ Master Card

Card No..... Card expiry date: .....

Signature_____

To Place Your Order:	eMAIL (24/7)	OR	FAX (24/7)	OR	PAYPAL (24/7)	OR	PHONE - (9-5, Mon-Fri)	OR	SNAIL MAIL
	silicon@siliconchip.com.au with order & credit card details		This form (or a photocopy) to (02) 9939 2648 with all details		Use PayPal to pay *silicon@siliconchip.com.au*		Call (02) 9939 3295 with your credit card details		This form to PO Box 139, Collaroy NSW 2097

*These prices and comparisons refer to Australian subscriptions. Other countries are subject to exchange rates – please see page 79 of this issue.

Mailbag: continued

Another vote for a portable audio recorder

I read in a recent edition of SILICON CHIP a letter of support regarding a portable audio recorder project. I would like to add my vote of support as well. A project of this sort would be welcomed by many readers I would think.

The features suggested so far seem practical and desirable. It could be a portable unit, perhaps around the size of the average multimeter, which has a removable SD card or similar for storage of the audio files and, if possible, a USB port so that files can be easily downloaded straight into a PC.

Naturally it would be battery-operated and ideally have some kind of LCD readout so that the user can see what the unit is doing – how much memory is left, the level of the incoming audio and any other basic parameters. Provision for one or two externally-mounted microphones would be good, as would stereo recording with the ability to switch to mono.

I am not sure how you'd deal with the AGC aspect, as the unit would need to be sensitive enough to pick up quiet sounds, as well as be able to handle high levels of audio – for example recording a fire-truck going past – without distorting. Whether this can be done via firmware or whether it would require a potentiometer to manually "back the gain off" a little would have to be determined.

I know that there are ready-made SD interface and audio recording modules on the market. Perhaps something could be designed around one of these?

S. Williamson,
Auckland, New Zealand.

purchased the item. A buyer in most situations will be issued a receipt for the extended warranty by the shop without anything to indicate that the extended warranty agreement was undertaken by an independent insurance company.

When the owner makes a claim on the extended warranty item, the owner naturally will contact the shop from which the item was purchased. Then the nightmare starts. The owner is then told that he or she needs to contact the insurance company. The insurance company has their appointed service centres and the owner has to then contact the appointed service centre.

If it is an LCD or plasma TV that is faulty, it could take a few weeks before a house call could be made and then another few weeks before a quote is given if the TV is not economical to repair. Then the insurance company could take another few weeks to respond to the quote before a claim could be entertained.

That's not all. When the claim is approved, the owner is "forced" to return to the same shop where he made the original purchase to facilitate that claim. In all, the whole process could take up to two months or even longer during the Christmas season. You are "forced" to buy from the same shop even though there could be special discounts from other shops which is rather annoying if that shop refused to match prices on insurance claims.

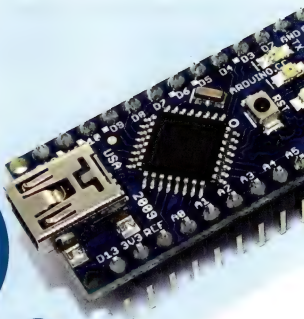
So if you originally made a flat-screen TV purchase of $6000, added another $600 for extended warranty and used that TV for three years and a fault occurred, you could find yourself given a claim return of $1600 for an insured amount for an item that was $6600. You have paid $600 for the extended warranty three years ago, which in three years monetary value is actually around $780. Then you are paid $1600 or less, depending on the size of the TV. You actually get paid $820 for an item that originally cost $6000.

So is an extended warranty worth the amount of hassle you have to go through? An extended warranty needs to be checked against the progress of technology. It is pointless to buy an extended warranty for an item that will be obsolete in six months.

Michael Ong,
Wembley, WA.

Comment: we might be proven very wrong but it does not seem likely that the dramatic price reductions that have occurred over the last few years, for items like large-screen TV sets, will be continued into the future. Instead, prices are likely to more or less stabilise while performance and features will continue to improve, as they have for laptop and desktop computers. SC

Introducing the micro development system taking the world by storm ...



ARDUINO™

By JONATHAN OXER*

The low-cost, open-source Arduino microcontroller development board has taken the hobby-electronics world by storm and is now gaining popularity with experienced engineers as well. So what's all the fuss really about? And anyhow, what's with the name "Arduino" and where did it come from? Read on!

Over the last couple of years SILICON CHIP has published a number of stories related to Arduino, including the "Arduino-compatible I/O Controller" project by Greg Radion featured in the April 2010 issue.

If you spend any time looking at microcontroller-based projects online you're bound to come across Arduino sooner or later. And as noted in last month's issue, there are now Arduino variants of our very popular Maximite microcomputer project (SILICON CHIP, March & April 2011).

In fact if you search for just the single word "microcontroller" in Google you'll find multiple Arduino references in the very first set of results. Arduino seems to be everywhere you look these days!

But what is Arduino? Why is there so much fuss about it? Does it have some secret sauce or magical property that makes it special? And why should a hobbyist or an engineer care anyway?

Everything about Arduino has been designed to give the lowest possible barrier to entry.

If you look at the circuit of a fairly minimal "Arduino-compatible" design in Fig.1, you'll see that part of the secret of the Arduino's success is that there is no secret.

From a hardware standpoint there's nothing magical that makes it different to any other simple microcontroller circuit you may come across.

It's just a common Atmel AVR microcontroller, a push-button and a bias resistor for manual reset, a crystal and some capacitors for the clock, a serial programming header with automatic reset control and a simple power supply.

You could build one yourself on a solderless breadboard in about ten minutes if you had the parts lying around. You may well have most of them already.

The only other item you would need with the circuit above is a commonly-available USB-to-Serial adaptor cable, so you could plug your home-made Arduino into your computer and load programs onto it.

Pre-assembled Arduino boards, such as the Uno reference design (meaning "One" in Italian, shown in Fig.2) and implementations based on it, typically have more features than the above minimal example.

These include on-board USB-to-Serial conversion, status and user-controlled LEDs, expansion headers, more advanced reset management, input current protection and other features but fundamentally they still build on this minimal underlying architecture.

This design simplicity has caused many experienced engineers to turn up their noses at Arduino, dismissing it as a trivial toy or something that's only useful for beginners.

However, don't disregard it prematurely; the intentionally simple design is just a tiny part of the story. Once you look into it a bit more deeply and see the various elements that combine to provide the overall Arduino ecosystem you'll begin to understand why so many people have fallen in love with it and why it's become such a smash hit.

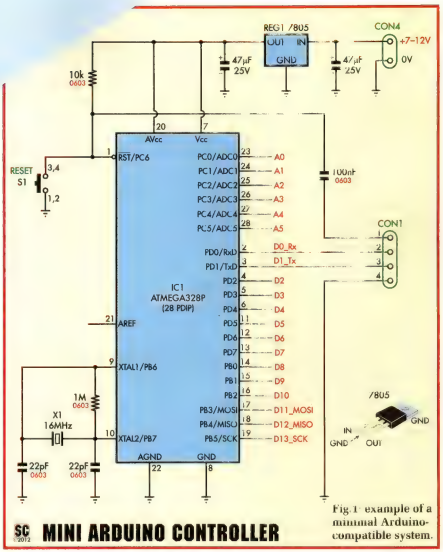


Fig.1: example of a minimal Arduino-compatible system.

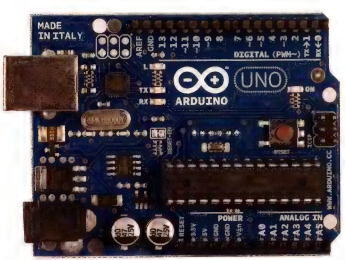
The Arduino boot-loader

One fundamental element of the Arduino platform is the boot-loader that is preloaded into the microcontroller's non-volatile flash memory.

A micro such as the ATmega328P has 32KB of flash (hence the "32" in the part number) for storing programs.

In a typical microcontroller development environment the program is loaded into flash using a special programmer that connects to an "ISP" (In System Programming) header and it stores the program in the micro starting at the beginning of the memory space.

Arduino, on the other hand, has a special boot-loader



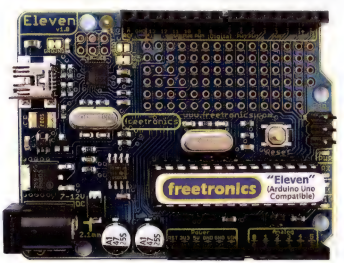


Fig.2: Arduino "Uno" reference design alongside the Freetronics "Eleven" Uno-compatible board

stored in its flash memory. The boot-loader begins executing as soon as the micro starts up and its main job is to check for the existence of a serial connection from a host computer trying to send it a new program.

If it finds one, it accepts the new program and writes it elsewhere into flash memory and then executes it. The boot-loader itself remains unchanged even after the new program has been loaded. If the boot-loader starts up and doesn't find a host with a new program waiting to be loaded, it simply jumps to the start of the previously loaded program and begins executing it.

This approach leaves slightly less storage available for user programs because a small amount is always reserved for the Arduino boot-loader but that's a small trade-off to make for the convenience of being able to quickly load a new program by USB, with no special hardware required.

All you need is a serial connection (USB cable or serial port) and the Arduino software on the host computer.

This highlights one of the main differences between the Arduino approach and traditional micro development boards and it's one of the reasons Arduino has become so popular even with experienced engineers.

Getting started with a traditional board from any of the major micro vendors has typically involved purchase of a multi-hundred dollar starter kit which can take weeks to arrive from an overseas supplier, then installation of a large and complex development environment on your PC, a laborious set-up process and often a cumbersome method for compiling and uploading the program to the micro.

Setting up a new development environment can take hours or days and involve reading dozens of pages of documentation and often it'll only run on Windows. If you prefer to use Linux or Mac you're out of luck. The assumption is that only "serious" developers will even attempt to use microcontrollers so it doesn't matter if the barrier to entry is fairly high.

Arduino, on the other hand, couldn't be any more different. The boards themselves are cheap and easy to get almost anywhere. There are numerous Australian on-line stores who can ship them straight to your door or just walk into

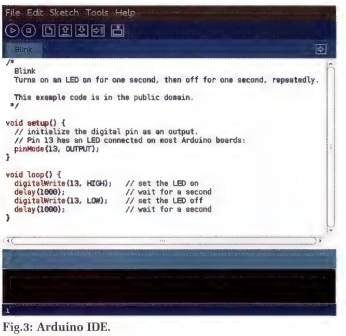


Fig.3: Arduino IDE.

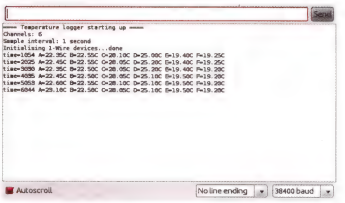


Fig.4: Serial console output.

any Jaycar store and you'll see a range behind the counter.

Take one home, download the open-source Arduino IDE software (which is available for Windows, Mac and Linux) to your computer, plug in the Arduino using a USB cable and you're ready to go. It doesn't even need a power supply because it can run from USB power.

Select one of the dozens of example programs included in the IDE, click the "Upload" button and the program will be compiled and sent to the board. Easy!

Even non-technical users with little knowledge of electronics or programming can have their first program running on the board within five minutes of opening the box. You'd be hard-pressed to find any other microcontroller development environment anywhere that can match the Arduino's "out of the box" experience.

That same instant-gratification effect doesn't only benefit beginners: it's just as attractive to expert developers once they've experienced it for themselves.

Many engineers who regularly use both Arduino and other development platforms find that when an idea pops into their head and they want to try it out, they naturally reach for an Arduino because it makes getting started on a new project so easy.

Later they may redesign and optimise the project using a dedicated PCB, and perhaps even switch to a different micro or platform entirelyif required, but the Arduino gets you through the initial "I wonder if this will work..." stage so effortlessly that it's natural to start using it for just about everything.

Arduino IDE software

The simplest way to get started writing programs for the Arduino is by using the official Arduino IDE software.

IDE means "Integrated Development Environment", an all-in-one program for editing, building and up-loading applications to the boards. It consists of a simple code editor with syntax highlighting and a number of convenience buttons for compiling and uploading "sketches" (the Arduino term for programs) to your board.

You simply prepare the program in the IDE, plug in your Arduino board using a USB cable, click the "Upload" button and your program is compiled and sent across to the board where it is saved in non-volatile memory.

The IDE also provides a very handy serial console, which makes it particularly easy for your program to display data and interact with messages between the Arduino and your computer.

Fig.4 shows typical output sent to the IDE serial console

from a connected Arduino.

Because Arduino doesn't contain any exotic hardware it can also be used as a generic AVR (a RISC – reduced instruction set computing) development board, allowing you to use more traditional software development tools to write programs for it and ignoring the Arduino IDE altogether.

Many advanced developers use their favourite code editor, such as Vim, Emacs or Eclipse and then use the avr-gcc compiler to prepare the software for up-load to the board using a tool such as AVRDUDE and an AVR-ISP Mk2 programmer.

While Arduino gives you a simple entry point to working with microcontrollers, it doesn't stop you from going way beyond the basics and developing very advanced projects using whatever tools you feel comfortable with.

Arduino IDE also has a sister project called Processing, which is a development environment designed to make it really easy to create cross-platform graphical applications to run on your computer. Combining the two, you can use Arduino IDE to create firmware to run on your Arduino and Processing to create a matching user interface that runs on your computer and communicates with it via USB.

You can use Processing for all kinds of graphs, displays and interactive computer applications.

Arduino language

In keeping with the overall Arduino philosophy, the development environment includes a number of features designed to simplify the process of creating simple programs while still allowing you to work with more advanced techniques if you feel comfortable with them.

The underlying language is compiled as C++ but most Arduino documentation deliberately avoids mentioning that fact to avoid scaring people off.

The development environment does such a good job of hiding the nasty details that some people spend years working with Arduino without even realising that they're writing in C/C++!

This simplification is largely the result of the Arduino library bundled with the development environment to provide a number of convenience functions for common operations. These convenience functions make the code much more readable and also increase portability across Arduino models by abstracting away details such as pin identifiers using simple labels.

For example, a common operation when writing C for an AVR microcontroller to drive a specific output pin high may look something like this:

```
PORTB |= (1<<PB2);
```

To an experienced developer that's a perfectly straightforward operation but to a beginner it's totally cryptic.

Even trying to explain that short line in plain English becomes a discussion of registers, ports and bit-wise operators that will leave a beginner bewildered. Even the pin identification isn't particularly straightforward.

The Arduino library hides all that complexity, providing standardised pin identifiers and allowing you to write a far more obvious but functionally identical piece of code like this:

```
digitalWrite( 10, HIGH );
```


Little Bird
ELECTRONICS
Official Arduino Distributor

Get Started With Arduino Today!

We have the largest range of Arduino and accessories in Australia!

Check Arduino out at:

www.littlebirdelectronics.com/arduino

Use the coupon code SILICONCHIP at checkout to save 10% off your order.

The end result of both those commands is the same but it's much easier to explain the second one to a beginner simply by saying "This command writes to digital pin 10 and sets it HIGH".

Pin identifiers

Pin identifiers are an important feature of the library because they allow Arduino models with different micros to address the expansion headers in a generalised way. For example, pin D10 on the expansion header is connected to micro pin PB2 on Arduino models based on the ATmega328P but on models based on the ATmega2560 it's connected to pin PB4.

You don't have to remember that distinction though, because you can just address it as "10" or even as "D10". All the boards available are marked the same and when your program is compiled for a specific board it'll work just fine without changing a single line of code.

Once again it's all about making development simple and intuitive.

The other important aspect of the Arduino development environment is the pre-processor. If you look at an example sketch you'll see that it's very "C-like" but is missing some of the important things you may be expecting such as function prototypes.

Consider the "Blink" sketch, which is considered to be the "hello world" of Arduino development:

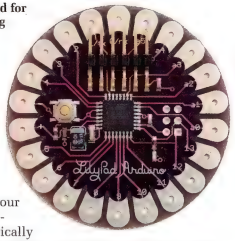
```
void setup() {
    // initialize the digital pin as an output.
    // Pin 13 has an LED connected on most Arduino boards:
  pinMode(13, OUTPUT);
}

void loop() {
  digitalWrite(13, HIGH);    // set the LED on
  delay(1000);               // wait for a second
  digitalWrite(13, LOW);     // set the LED off
  delay(1000);               // wait for a second
}
```

That is the entire program and it's all stored in a single file and displayed in a single window, in the IDE. This example includes the two "must haves" for any Arduino program: the "setup()" function and the "loop()" function. The "setup()" function is executed once when the program starts and the "loop()" function is then repeated indefinitely.

Other than the missing function prototypes mentioned previously, you'll also notice that there's no "main()" function.

Fig.6: Arduino Lilypad for "wearable" computing projects.



The Arduino pre-processor takes care of all that for you. When you click "compile" in the IDE, the first thing it does is run your code through the pre-processor to automatically generate prototypes and a "main()" function and then passes the result to the GCC compiler for the final conversion into hex for use by the micro.

Once again, keep in mind that this doesn't prevent you writing your programs the traditional way and explicitly defining your own prototypes, if you need to.

The pre-processor is just a convenience that lowers the barrier to achieving simple things, while still allowing you to do complex things if you have the knowledge to do so.

The Arduino community

For many enthusiasts the "killer" feature of the Arduino isn't the hardware or the software, it's the community of users that has grown up around it.

The community is very different to what you may expect to find associated with a microcontroller platform. Rather than a narrow, focused group of electronic engineers, it's a free-wheeling assortment of students, artists, hobbyists, mechanical engineers, automation enthusiasts and anyone else you can think of.

That's because many Arduino users do not typically come to the platform through the expected path of electronic engineering but instead arrive at it from some other discipline or interest and see it as simply another building block to achieve whatever larger end result they're working on.

Looking through the Arduino forums you'll find people working on all manner of projects ranging from kinetic sculptures to DIY home-automation systems and experimental musical instruments.

And because many Arduino projects are built as one-off creations with no thought of commercial gain, users are often very happy to publicly document their work for the benefit of anyone else who may be interested. This has the

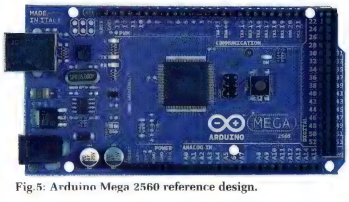


Fig.5: Arduino Mega 2560 reference design.

Fig.7: LCD & Keypad Shield mounted on an Arduino-compatible board.

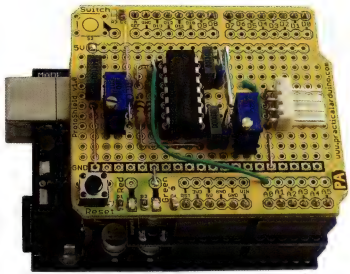


Fig.9: A "prototyping" shield with parts fitted for a custom project.

snowballing effect of providing resources and inspiration to others, who subsequently go on to document their own projects and so on.

Of course the community also includes many very experienced electronic engineers and a vibrant commercial ecosystem has grown up around it to supply a wide assortment of specialist hardware and services.

Arduino variants

By far the most popular Arduino models are those based on the "Uno" reference design shown in Fig.2. The Uno provides four main functional elements: the AVR microcontroller, a simple 5V regulated power supply, a USB-to-Serial converter for loading new programs onto the board and I/O headers for connecting sensors, actuators and expansion boards.

Many other versions including the locally-designed Freetronics "Eleven", shown in Fig.2, fit the same physical form-factor and are functionally compatible, while providing enhancements or additional features not found in the reference design.

For example, the Eleven adds a prototyping area so you

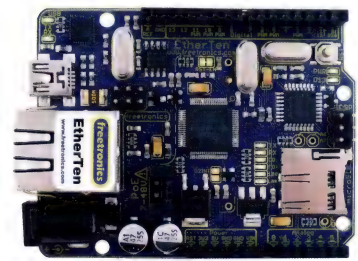


Fig.10: The Freetronics "EtherTen" Arduino-compatible board with built-in Ethernet.

Australian Robotics

Sparkfun Inventor's Kit for Arduino

The SparkFun Inventor's Kit is a box of goodies to get the Arduino beginner started with programmable electronics.
http://bit.ly/uS3Pgm

$94.90

Arduino Uno (rev 3)

The basic dev board to get you going.

$32.50

http://bit.ly/tfF1Cf

Arduino Ethernet Shield (rev 3)

Stack on your Arduino for web connections.

$54.95

http://bit.ly/vrr4SE

Freetronics Etherten

An Arduino with native Ethernet.

$69.95

http://bit.ly/ttIMwH

Shop online for over 600 more Arduino-related products at:

australianrobotics.com.au

Hobbyists – computer enthusiasts – programmers – this is for YOU!

Melbourne Hackerspace brings you the first

Melbourne Mini Maker Faire®

JANUARY 14 2012

Don't know what a Maker Faire is all about? Visit http://makerfaire.com

for more information, email makerfairemelboure@gmail.com or visit http://makerfairemelbourne.wordpress.com/

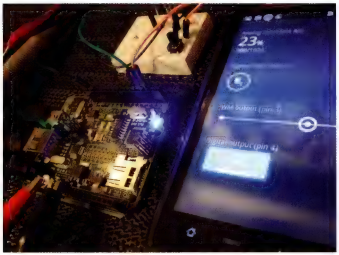


Fig.11: USBDroid Arduino-compatible board connected to an Android mobile phone.

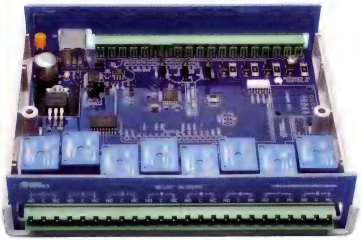


Fig.12: Arduino-Compatible I/O Controller from Ocean Controls, featured as a project in the April 2010 issue of SILICON CHIP.

can add your own parts, isolates the general-purpose LED connected to pin 13 on most Arduino boards using a FET, uses a mini-USB socket instead of a regular USB socket and moves the status LEDs to the edge of the board so they are still visible when an expansion board is mounted on top.

The classic Uno form-factor isn't the only option though. Many other variants exist, including the "Mega" form factor shown in Fig.5 that provides more I/O headers and memory, using a more powerful ATmega2560 micro.

Once again there are multiple derivative development boards using that same form factor to take advantage of compatibility with expansion boards.

There are also smaller versions, such as the Arduino Nano that's a mere 43mm x 19mm and even some very unusual form factors such as the Arduino Lilypad, shown in Fig.6. The Lilypad is designed to be sewn into clothing using special conductive thread for use in wearable computing projects. It's been put to some very imaginative uses, such as a cycling jacket with turn indicators wired into it!

Even though these different Arduino-compatible boards have wildly varying form factors, they're still compatible with the same development environment and can mostly run the same software. Unless it relies on special hardware features of a particular model, a sketch can be uploaded to a Lilypad or a Mega or an Uno or a Nano and it'll run just the same on every board.

Expansion Options

A basic Arduino on its own isn't very useful. It's designed to be the foundation of whatever larger project you dream up. The fairly minimal hardware functionality can be expanded in three main ways.

The first method is to use expansion boards called "shields" that can be plugged into the top of the expansion headers. Shields can be complete pre-built boards with all parts already installed for a specific purpose, such as the Freetronics LCD & Keypad Shield available from Jaycar and various on-line suppliers, that adds a display and some input buttons to your projects as shown in Fig.7.

There is an amazing variety of pre-built and kit shields available, ranging from the obvious to the obscure. The "Arduino Shield List" website has details of about 300 different models from more than 100 manufacturers, covering everything from LCD modules and WiFi to H-bridge motor drivers and Geiger counters.

Alternatively, blank shields called "Prototyping Shields" like the one shown in Fig.9 provide a matrix of free space for you to add your own parts to suit your specific project.

Another approach is to use Arduino-compatible boards that incorporate extra functionality right onto the main board itself without the need for a separate shield.

For example, the Freetronics EtherTen shown in Fig.10 is an Australian-designed Arduino board with LAN connectivity, Power-over-Ethernet capability and a microSD card slot, all within the "Uno" form factor and shield compatibility. Any project you'd like connected to the internet, a network, even serving web pages and monitoring can be run on this board.

Another example of a special-purpose board is the USBDroid shown in Fig.11, which is an Arduino-compatible board with USB host connectivity built-in. It's designed to connect to Android-powered devices such as tablets and phones as a peripheral, making it possible to build your own custom add-on hardware for smart-phones and tablets.

Finally, you might decide to design your own integrated special-purpose board to suit your own requirements, while building on the basic Arduino architecture. Because the Arduino reference designs are published under Open Licenses, you can use them as a starting point to create your own variant.

This is the approach Greg took with the Arduino-Compatible I/O Controller project shown in Fig.12, which doesn't look anything like an Arduino because it's designed to fit in a case with a bunch of relays mounted on it.

From both a hardware and software point of view, though, it's just another Arduino that can be programmed using the Arduino IDE but this one has the great advantage of sensing and controlling power items directly by its on-board additions.

Learn more

This introductory article has focused mainly on the technical aspects of Arduino but as we hinted at the beginning, there is a fascinating back-story to the origins of the project and how it grew from humble beginnings as a classroom exercise in the Interactive Design Institute Ivrea

OCEAN CONTROLS

We would like to wish everyone a Happy and Prosperous New Year

Arduino Starter Kit

Is a great gift for beginners and professionals alike. Included is an Arduino Uno board, a multitude of inputs, outputs, and sensors to get you started in the wonderful world of Arduino.
ARD-005 $59.95+GST

Arduino Inventers Kit is a box of goodies to get the beginner started with programmable electronics. Includes an Arduino Uno, baseplate, and heaps of sensors. A booklet shows how to build 12 basic circuits, no soldering required
ARD-015 $93.50+GST

Threaded Shaft Stepper Motor As the motor runs, it moves along the 100mm long shaft at a specific rate of 1cm per 5 full rotations. The shaft is keyed on one end.
These are a good choice for linear motion where precision and repeatability are important.
SFM-001 $29.50+GST

Electronic Thermostat The N322 thermostats have two relay outputs which can be configured for heating or cooling or a number of different alarm modes. Four front panel keys allow easy configuration. Comes with a 2m waterproof NTC thermistor sensor which can be extended to 50m.
CET-001 $65+GST

LED Bulbs.
These BA9S LED bulbs can be powered from 24VAC or DC. Available in white, red, green, blue and yellow. Suitable for most industrial 22mm indicators
HEL-050 $1.45+GST

Relayduino
A USB or RS485 controlled IO module for interfacing PCs to real world applications, such as controlling lights and sprinkler systems. Fully arduino compatible comes with 8 relay outputs, 4 digital inputs and 3 analog inputs.
KTA-223 $135+GST

Solar Heating Controller
The N321S typically switches on-off a water circulation pump based on the temperature difference between the solar collector and the thermal reservoir or pools.
Simple to setup the controller comes with two 3m long NTC-type temperature sensors.
CET-033 $79+GST

Temperature and Relative Humidity Transmitter
These sensors measure both temperature and relative humidity with either 0-10V or 4 -20mA outputs. Wall and duct mount available
RHT-006 $209+GST

Rotary Encoder
A 1,000 line quadrature rotary encoder with A, B and Z NPN-style outputs. 6 mm diameter shaft with flat. 5 to 24 V DC powered.
IBE-002 $135+GST

Labjack U3
USB data acquisition unit with 16 flexible I/O Each I/O can be a 12 bit analog input, digital input or output.
2 of the lines can also be configured as counters and timers. All Windows software and drivers, Labview drivers included.
LAJ-021 $149.95+GST

4-20mA Loop Powered Panel Meter
4 Digit fully programmable by front panel keys
IP65 Box.
CMI-005 $149+GST

Flexible Couplings
We now have a selection of flexible couplings for our stepper and servo motors.
From $13.14+GST

Voltage Datalogger
The Site-Log LPVB-1 is a 7-channel, battery powered, stand alone voltage data logger which records up to 4Mb of data for later retrieval via USB/serial. With a 10 year battery life, a 16-bit ADC and programmable input range, the data logger is well suited to science and laboratory applications.
MED-001 $549+GST

M12 Inductive Proximity Switches
These switches activate when ferrous metals are close. Fitted with NO and NC contacts and LED indicator. Powered from 10-30VDC.
IBP-015 $24.95 +GST

Triple Axis Accelerometer A great low-g sensor with analog voltage outputs and adjustable sensitivity (±3 g or ±11 g). Has an onboard 3.3V regulator.
POL-1252 $17.50+GST

Water Level Sensors
With this pressure sensor you can measure water levels up to 20 metres deep. Fitted with 25metres of cable and 4-20mA output.
IBP-102 $359+GST

Waterproof Temperature Sensor
The sensor is equipped with a DS18S20 1-Wire temperature sensor embedded into the probe with a 15metre cable and RJ12 connector.
GJS-001 $19.50+GST

DIN Rail Springcage Terminal Block
Speed up wiring. Simply use a screwdriver to lift the spring and insert the wire for a vibration proof connection.
TRM-225 $0.99+GST

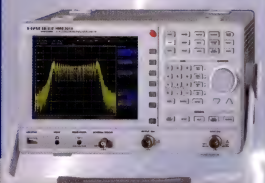
Ocean Controls
Factory 3/24 Wise Ave
Seaford Vic
Ph: 03 9782 5882
www.oceancontrols.com.au

Great Value in Test & Measurement

HAMEG
Instruments
A Rohde&Schwarz Company

350 MHz 2/4 Channel Digital Oscilloscope HMO3522/HMO3524

- 4GSa/s Real Time, 50GSa/s Random Sampling, Low Noise Flash A/D Converter (Reference Class)



Sensitivity

3GHz Spectrum Analyzer HMS3000/HMS3010

- Frequency Range 100kHz...3GHz
- Tracking Generator HMS3010 -20...0dBm

Accuracy

Quality

Programmable 2/3 Channel High-Performance Power Supply HMP2020/HMP2030

Simplicity

HMP2020	1 x 0...32V/0...10A	
	1 x 0...32V/0...5A	188W max.
HMP2020	3 x 0...32V/0...5A	188W max.

Rohde & Schwarz (Australia) Pty Ltd
Unit 2, 75 Epping Road, North Ryde, NSW 2113
sales.australia@rohde-schwarz.com

in Italy in 2005.

In late 2010 a short film called "Arduino: The Documentary" was released and it's well worth watching if you want to get a better feel for the culture and objectives of the Arduino core development team and the broader Arduino community. You can see it online at http://vimeo.com/18539129.

The definitive source of Arduino information is the official website at www.arduino.cc. It has a huge amount of information for both beginner and advanced developers, including very active user forums, tutorials, hardware guides and a language reference. Example projects (including both hardware designs and software source code) are available to help beginners get started.

Often it's handy having documentation in hard-copy. For a gentle introduction a good option is "Getting Started With Arduino", by Arduino co-founder Massimo Banzi. Once you've got past the basics, a much more substantial book to walk you through a number of projects and more advanced techniques is "Practical Arduino" by Hugh Blemings and myself. Both are available for purchase on-line and in your local Jaycar store.

For Aussie developers there are a wealth of local resources, including an excellent series of online tutorials written by John Boxall. John's tutorials are now considered a prime reference for Arduino users everywhere and can be found at www.tronixstuff.com

Another local resource is the Freetronics discussion forum, which caters to Australian Arduino users and also provides a venue for discussion of more general electronics issues. I'm co-founder of Freetronics, so you'll often find me in that forum! Join the conversation at http://forum.freetronics.com/

Hackerspaces

Finally, there is a rapidly growing contingent of Arduino users at hackerspaces around Australia. Hackerspaces are community-operated physical places, where people can meet and work on their projects.

Hackerspaces are good, welcoming places for newcomers to learn about many aspects of electronics including Arduino and they'll be covered in detail in a future article. For now a good starting point for finding a local hackerspace is http://hackerspaces.org/wiki/Australia

Over the coming months we hope to feature some projects based on the Arduino, so stay tuned! SC

*About the author, Jonathan Oxer

While Arduino has millions of afficianados around the world, Jonathan Oxer is widely regarded as one of the "gurus". He's been called "Australia's Geekiest Man" – he's one of the few people in the world who has actually implanted an RFID chip in his body so he could experiment with RFID!

He is the author (and co-author) of several books, including "Practical Arduino" shown at left.

Along with Marc Alexander, he's the principal of Freetronics Pty Ltd which was established in 2010 to cope with the deluge of requests for kits, parts etc relating to the book. (Freetronics sell online at www.freetronics.com or via a number or resellers in Australia and worldwide).

BRIGHT IDEAS. STOCKED HERE.

Let element14 bring your ideas to life with an array of 10,000 lighting products and solutions, including design resources like application guides, white papers, notes and more. And with local service and technical help, you can count on us to support your needs – 24/7.

As a part of the Premier Farnell group, element14 brings you 70+ years of trusted electronics distribution expertise, along with an innovative online engineering community, where you can collaborate with experts, access technical information and use helpful tools. So trust element14 to power all your bright ideas.

Global portfolio of industry leading manufacturers:

Avago | Chicago Miniature Lighting, LLC | CREE | LINEAR | molex | TE | Texas Instruments

HOW MAY WE HELP YOU TODAY?

WEBSITE:
au.element14.com/lightingsolutions
nz.element14.com/lightingsolutions

MOBILE SITE: m.element14.com

PHONE:
Australia 1300 519 788
New Zealand 0800 90 80 80

FAX:
Australia 1300 361 225
New Zealand 0800 90 80 81

TECHNICAL SUPPORT:
au-technical@element14.com
nz-technical@element14.com

SALES:
au-sales@element14.com
nz-sales@element14.com

FLEXIBLE PAYMENT OPTIONS:

element14

The new global face of Farnell

By JOHN CLARKE

STEREO COMPRESSOR

Do you hate the way the sound level on your TV suddenly jumps during the advert breaks? Or do you find that the sound levels vary widely when switching between digital TV stations? Or maybe you have problems listening to CDs or MP3s in your car or against the background din during a party? Are the soft parts too soft and the loud parts too loud? This Stereo Compressor will solve that problem. It reduces the dynamic range of the signal while still maintaining clean sound. The unit is also ideal for use with PA systems.

Features & Specifications

Main Features

- Stereo compression
- Input level & volume controls
- Power switch & indicator LED
- Several power supply options

Specifications

Signal-To-Noise Ratio .....-75dB (20Hz - 20kHz filter) and -79dB "A" weighted with respect to 1V in and 1V out

THD+N ..... 0.005% with compression disabled; 0.007% @ 10kHz & 2:1 compression; 0.17% @ 1kHz & 2:1 compression; 1.6% @ 100Hz & 2:1 compression

Channel Separation ..... 58dB (unweighted)

Frequency Response .....-1.5dB at 10Hz, -3dB at 33kHz

Compression Ratio ..... typically 2:1 from +20dB to -20dB input with respect to 0.318V RMS at the compressor input – see Fig.3

Power Consumption ..... 17mA at 15VDC; 40mA for supplies over 15V; (±40mA for supplies over ±15V)

COMPACT DISC PLAYERS and many MP3 players give great sound quality but they usually have a wide dynamic range. That means that the sound level can range from almost inaudible through to very loud, all without touching the volume control.

That can be a problem in noisy environments. For example, in a car, while the loud passages can be heard, the soft parts may well be lost due to road and engine noise. A similar problem can occur with PA systems, where crowd noise can drown out quiet passages in the sound.

In those situations, simply turning up the volume does not solve the problem. While the quiet bits may then be more audible, the loud sections can be ear-shattering and may even overload the amplifier, causing audible distortion.

What we need to do instead is "compress" the dynamic range of the signal so that the loud parts are not quite so loud and the soft parts are not nearly so quiet. And that's what this Stereo Compressor does – it continuously adjusts the signal level by amplifying the quiet passages and attenuating the louder passages, so that the overall volume range is much reduced.

Listening to TV

A common annoyance for TV viewers is the way the average sound level suddenly jumps during advertising breaks or when you switch between digital stations. Some stations have quite low sound levels and so you have to turn up the volume. Then you switch channels and you get blasted! That's bad enough but it's much worse if you're listening via headphones.

Again, an audio compressor is the answer, assuming that you're using an external amplifier. By making the volume more constant, it will enable you to set the volume to a level that's comfortable at all times. It sure beats having to hurriedly hit the "mute" button each time there's an ad break.

PA systems & mood music

Apart from its use in cars and for listening to TV via headphones, an audio compressor is a "must-have" item when it comes to PA systems and mood music. That applies whether you want to provide background music at a dinner party or you want to pipe music into a PA system at a restaurant. In each case, the problem is the same – all those people talking at once creates a high level of ambient noise which drowns out the soft passages in the music.

Once again, an audio compressor is the answer to this problem.

Not all audio compressors are as effective as this design though. One problem with some units is that they markedly increase the noise at low signal levels due to the much increased gain at those levels. However, this problem is largely avoided in our unit because it features a "downward expander". This reduces the gain once the incoming signal drops below a certain level (or threshold point).

As a result, the noise produced is considerably less than that from units that lack downward expansion.

Presentation

As shown in the photos, the Stereo Compressor is housed in a small slimline plastic case. It has two rotary controls, one to adjust the input level (which sets the amount of compression) and the other to adjust the volume (or output level). A power switch and an indicator LED are also included on the front panel. Four RCA connectors on the rear panel are used for the inputs and outputs.

Various power supply options are available for the Stereo Compressor. It can be powered from AC or DC supplies, eg, a DC or AC plugpack, a 12V battery in a car or from the supply rails of a power amplifier. Table 2 shows the various options.

How it works

Let's now take a look at the circuit details – see Fig.1. There are two separate signal paths: via IC1a, IC2a & IC3a for the right channel and via IC1b, IC2b & IC3b for the left channel. These two signal paths are identical so we'll just describe the operation of the right channel.

The incoming audio signal is AC-coupled to op amp IC1a via a 10Ω resistor and a 10µF NP (non-polarised) capacitor. A 470pF capacitor bypasses RF (radio frequency) signals to ground,

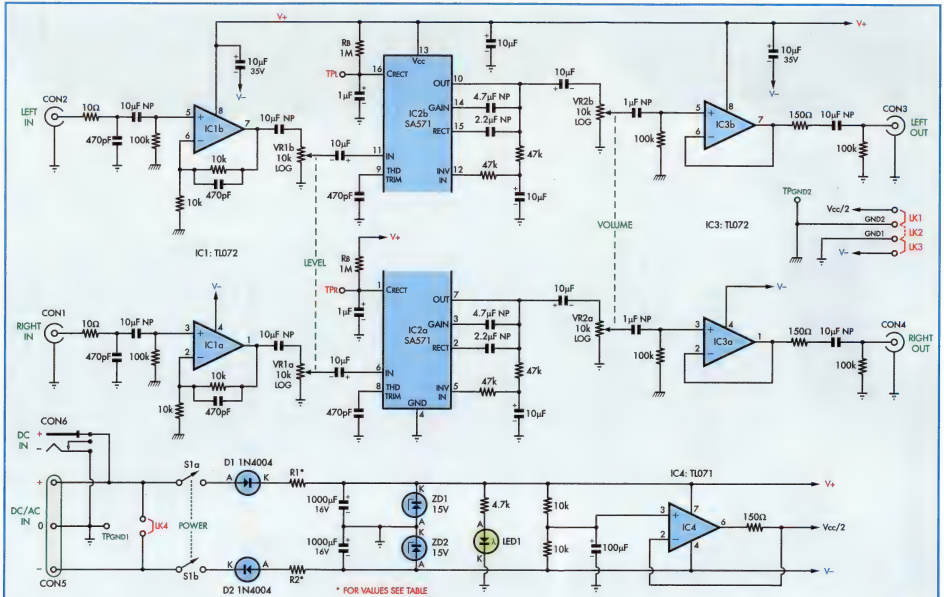


Fig.1: the incoming audio signal to each channel is amplified by op amps IC1a & IC1b and then fed to IC2 which is an SA571 stereo compandor. IC2 performs the signal compression and its outputs then drive buffer stages IC3a & IC3b via output level control VR2.

while pin 3 of IC1a is tied to ground via a 100kΩ resistor to set the bias for this stage.

This 100kΩ resistor connects to either the signal ground or to a half-supply ground, depending on the power supply configuration.

In particular, note the two different ground symbols used in the circuit. If a dual-rail (±) supply is used to power the op amp, the bias for IC1a is set to 0V so that the op amp's output can swing symmetrically above and below 0V. On the other hand, if a single-rail supply is used, the op amp is biased to allow its output to swing above and below the half-supply voltage.

IC1a operates as a non-inverting amplifier with a gain of 2, as set by the 10kΩ feedback resistor between pins 1 & 2 and the 10kΩ resistor from pin 2 to ground. The 470pF capacitor across the feedback resistor rolls off the high-frequency response above 33kHz.

IC1a's output is AC-coupled via a 10μF NP capacitor to the top of VR1a. This potentiometer acts as a level control and is adjusted for optimal operation of the following compressor stage based on IC2a.

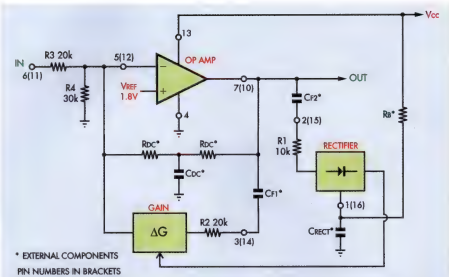
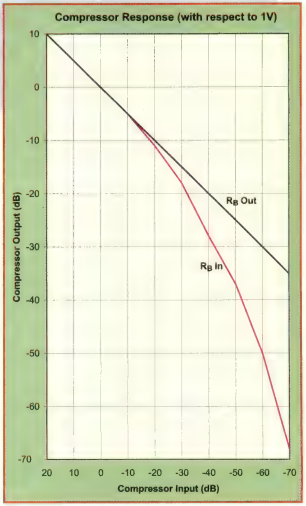


Fig.2: the basic configuration of each compressor stage inside IC2. The gain element is placed in the feedback network of the op amp and is controlled by the filtered output from the rectifier.

Fig.3: this graph plots the compressor's output as a function of its input signal. It provides a nominal 2:1 compression but it has a non-linear response with resistor R_B in (see text).



Compressor circuit

IC2 is an SA571 stereo compandor IC. The word "compandor" is a contraction of the words compressor and expander and it means that this IC can be used as either a signal compressor or a signal expander.

In this circuit, the SA571 has been configured to operate as a compressor. Its basic operation is shown in Fig.2 (one channel only shown). It comprises two full-wave averaging rectifiers, two gain elements and a dual op amp for stereo applications.

When used as a compressor, the gain element is placed in the feedback loop, between the op amp's output and its inverting input. The input signal is applied to the inverting input via a 20kΩ resistor (R3), while the non-inverting input is biased above ground to allow a symmetrical output swing.

In practice, the op amp's output is biased to $(1 + (2R_{DC} \div R4)) \times Vref$. Vref is about 1.8V, R4 is 30kΩ and the external R_{DC} resistors in our circuit are 47kΩ. As a result, the op amp's output sits at about 7.44V.

During operation, the full-wave averaging filter monitors the op amp's output and rectifies the signal. This rectified signal is then averaged (smoothed) to provide a DC voltage that controls the gain element. If the signal level is low, then the DC control voltage is low and the gain element's resistance is high. As a result, the op amp operates with high gain and so low-level signals are boosted.

Conversely, if the input signal level is high, the control voltage is also high and this reduces the gain element's resistance to lower the gain. So the overall effect is that low-level signals are boosted while high level signals are reduced.

Fig.3 plots the compressor's output against its input signal level. It's set up to provide a nominal 2:1 compression. Note, however, that at low signal levels the gain increase is non-linear and is reduced, due to the addition of resistor R_B. Without this resistor, the compressor would operate with a nominal 2:1 compression for signals right down to -80dB (ie, 80dB below the 0dB reference) and this would lead to a significant increase in noise.

The SA571 requires only a few external parts to produce a working compressor stage. As shown in

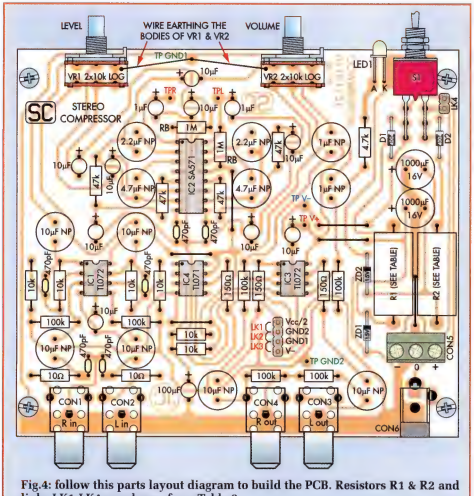


Fig.4: follow this parts layout diagram to build the PCB. Resistors R1 & R2 are chosen from Table 2.

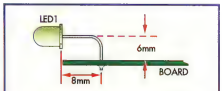


Fig.5: bend the leads for the LED as shown here before installing it on the PCB. The centre line of the lens must be 6mm above the board surface.

Fig.1, the signal from VR1a's wiper is AC-coupled to IC2a's pin 6 input, while the output at pin 7 is AC-coupled to the gain cell at pin 3 and the rectifier at pin 2. The two associated 47kΩ resistors are in the feedback path between the internal op amp's output (pin 7) and its inverting input (pin 5) and are the R_{DC} resistors shown in Fig.2.

The smoothing (averaging) capacitor for the rectifier is at pin 1 while resistor R_B (1MΩ) is connected to the V+ rail to provide non-linear compression at low levels (to reduce noise). A 470pF capacitor is used to decouple the distortion trim input at pin 8 (this input is not used here).

IC2a's output at pin 7 is AC-coupled to volume control VR2a. This sets the signal level applied to output buffer stage IC3a. IC3a's pin 3 input is biased using a 100kΩ resistor to ground. As before, this ground point can be set to either 0V or to half-supply, depending on the power supply used.

IC3a operates as a unity gain buffer stage. Its output appears at pin 1 and this is then fed to output socket CON4 via a 150Ω resistor and a 10µF NP capacitor. The 150Ω resistor isolates IC3a's output from the capacitance of the output leads, to prevent instability.

Power supply

Power for the circuit can come from either a 12-30V DC source, a ±12-25V DC source or an 11-25V AC source. The current consumption is about 40mA.

The simplest supply arrangement is to use a ±12-30V DC source (ie, a dual-rail supply, as often found in stereo amplifiers). This is fed into CON5 and switched by S1a & S1b. Diodes D1 & D2 provide reverse polarity protection and the following 1000µF capacitors filter the supply rails to reduce ripple.

Zener diodes ZD1 & ZD2 limit the supply rails to ±15V while resistors R1 & R2 limit the current through ZD1 & ZD2. The values of these resistors depend on the external supply voltage and are chosen from Table 2.

With this supply arrangement, the two different grounds on the circuit are tied together using link LK2 (see Table 2). This biases the op amp inputs at 0V so that the signal swings symmetrically above and below ground.

Using an AC supply

An 11-25V AC supply can also be used to derive dual (±) supply rails. In this case, the "+" and "-" rails are connected together immediately following CON5 using link LK4. One side of the AC supply then goes to 0V, while the other goes to either the "+" input or the "-" input. Alternatively, the AC supply can be fed in via CON6.

With this supply configuration, D1 & D2 function as half-wave rectifiers, with filtering again provided by the two 1000µF capacitors. D1 conducts on the positive half-cycles to produce the positive rail, while D2 conducts on the negative half-cycles to produce the negative rail.

As before, the two grounds (GND1 & GND2) are connected using link LK2 and current-limiting resistors R1 & R2 are selected using Table 2.

12-30V DC supply

The arrangement is a bit more complicated for a 12-30V DC supply. That's because the signal can no longer swing below the 0V rail, since there's no negative supply. As a result, the op amps must be biased to a half-supply voltage, so that the signal can swing symmetrically about this voltage.

This half-supply voltage is derived using a voltage divider consisting of two 10kΩ resistors between the positive supply rail and ground. A 100µF capacitor filters this half-supply rail and this is then fed to the non-inverting input (pin 3) of IC4.

IC4 is wired as a unity gain buffer stage. Its output at pin 6 provides the half supply via a 150Ω decoupling resistor. This half-supply rail is then used to bias op amps IC1 & IC2.

In this case, links LK1 & LK3 are

This view shows the fully-assembled PCB. Note the two wire links used to earth the metal bodies of the pots.

used (but not LK2). LK1 connects the half-supply rail to the op amp signal grounds, while LK3 connects the op amp negative supply pins to the power supply ground.

The supply itself is connected between the "+" and the 0V (ground) terminals of CON5 or it can be fed in via CON6.

Regardless of the power supply configuration used, LED1 lights when power applied via on/off switch S1. This LED is powered from the nominal +15V rail via a 4.7kΩ current-limiting resistor (note: this rail will be at +12V if a 12V DC supply is used).

The AC-coupling capacitors at the inputs and outputs of the op amps remove any DC component from the signal. In particular, they are necessary when the op amp outputs are biased to half supply. For the other supply options, the capacitors prevent DC coupling to the input stages of IC1a & IC1b and prevent DC flow in the level and volume controls (which would cause noise).

Construction

The assembly is straightforward, with all parts mounted on a PCB coded 01201121 and measuring 118 x 102mm. This is housed in a plastic instrument case measuring 140 x 110 x 35mm. The front and rear panels supplied with the case are replaced with PCBs with blue solder masks and screen printed lettering. These are mechanically robust, look good and the holes are all pre-drilled.

The main PCB is designed to mount onto integral bushes within the box. Make sure the board fits correctly within the box and that the mounting holes line up with these bushes. The corner mounting holes should all be 3mm in diameter.

Fig.4 shows the parts layout on the PCB. Begin by checking the PCB for any defects (rare these days), then install the six wire links and the resistors. Leave R1 and R2 out for the moment but don't forget the link between them. Table 1 shows the resistor codes but you should also use a digital multimeter to check each one before installation.

Diodes D1 & D2 and zener diodes ZD1 & ZD2 can go in next. These must be correctly orientated. Follow with PC stakes at the four six points (TP V+, TP V-, TPL, TPR, TP GND1 & TP GND2) and the 2-way (LK4) and 4-way (LK1-LK3) pin headers.

The four ICs are next on the list. These can either be soldered direct to the PCB or mounted via DIL8 and DIL16 sockets. Take care with their orientation – the ICs all face in the same direction. Note also that IC1 & IC3 are both TL072s, while IC4 is a TL071 – don't get them mixed up.

Now for the capacitors. Install the ceramic capacitors first before moving on to the larger electrolytics. The 10µF "NP" (non-polarised) capacitors can be mounted either way around but the remaining electrolytics must all be installed with the correct polarity.

The larger hardware items can now be installed. These include switch S1, the two pots (see below), the four RCA sockets and one of the power supply sockets (CON5 or CON6). Install CON6 if you intend using either a single rail DC supply or an AC supply.

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	1MΩ	brown black green brown	brown black black yellow brown
❑	6	100kΩ	brown black yellow brown	brown black black orange brown
❑	4	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	6	10kΩ	brown black orange brown	brown black black red brown
❑	1	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	3	150Ω	brown green brown brown	brown green black black brown
❑	2	10Ω	brown black black brown	brown black black gold brown

The rear panel provides access to the input and output RCA sockets, as well as to the power socket. Omit the power socket and fit a rubber grommet if you intend using a dual-rail supply.

Alternatively, install CON5 instead if you intend using a dual-rail supply (ie, with "±" rails). A grommet is then installed at CON6's location on the rear panel so that the external supply leads can be fed in.

Before mounting the two pots, trim their shafts (using a hacksaw) to suit the knobs (about 13mm for the knobs specified). The pots are then pushed down so that they sit flush against the PCB and their leads soldered.

Once they are in position, solder a length of tinned copper wire between each pot body and TP GND1. Note that it will be necessary to scrape away some of the coating from the pot bodies to get the solder to adhere. You will also need to wind up the temperature of your soldering iron if you have a soldering station.

Installing the LED

LED1 is installed by first bending its leads down through 90° about 8mm from its body but check that it is correctly orientated before you do this (see Fig.5). The LED is then installed so that the centre of its lens is 6mm above the board, so that it will later protrude through its hole in the front panel.

A 6mm-high cardboard spacer or some other suitable 6mm spacer will make this job easier.

R1, R2 & the links

Resistors R1 & R2 can now be installed, depending on the power supply to be used with the device. Table 2 shows the resistor values for the various supply voltages.

Links LK1-LK4 (in the form of jumper shunts) must also be selected and installed according to the power supply:

- For a dual-rail supply, install LK2 and omit LK4;
- For an AC supply, install both LK2 & LK4; and
- For a single-rail DC supply, install LK1 & LK3 and omit LK4.

Table 2: Choosing R1 & R2 & Setting The Supply Links

Input Voltage	R1	R2	Links	Power Input
±25VDC	270Ω 5W	270Ω 5W	LK2 in, LK4 out	+, 0, -
±20VDC	120Ω 1W	120Ω 1W	LK2 in, LK4 out	+, 0, -
±15VDC	10Ω 1/2W	10Ω 1/2W	LK2 in, LK4 out	+, 0, -
±12VDC	10Ω 1/2W	10Ω 1/2W	LK2 in, LK4 out	+, 0, -
25VAC	470Ω 5W	470Ω 5W	LK2 & LK4 in	+, 0 or CON6
20VAC	390Ω 5W	390Ω 5W	LK2 & LK4 in	+, 0 or CON6
18VAC	270Ω 5W	270Ω 5W	LK2 & LK4 in	+, 0 or CON6
15VAC	120Ω 1W	120Ω 1W	LK2 & LK4 in	+, 0 or CON6
11VAC	10Ω 1/2W	10Ω 1/2W	LK2 & LK4 in	+, 0 or CON6
+30VDC	390Ω 5W	NA	LK1 & LK3 in, LK4 out	+, 0 or CON6
+25VDC	270Ω 5W	NA	LK1 & LK3 in, LK4 out	+, 0 or CON6
+20VDC	120Ω 1W	NA	LK1 & LK3 in, LK4 out	+, 0 or CON6
+15VDC	10Ω 1/2W	NA	LK1 & LK3 in, LK4 out	+, 0 or CON6
+12VDC	10Ω 1/2W	NA	LK1 & LK3 in, LK4 out	+, 0 or CON6

Final assembly

With the PCB assembly now complete, it can be installed in its plastic case. Before doing this though, it will be necessary to remove the surplus mounting posts on the base, since they will otherwise foul the component leads under the PCB. This can be done by twisting them off using pliers but be sure to leave the four corner posts.

As stated above, the front and rear panels supplied with the case are replaced with screen-printed (and solder masked) PCBs. It's just a matter of slipping them into place (ie, at the front and rear of the main PCB), then slotting the assembly into the case and installing the four self-tapping screws at the corners.

The assembly can now be completed by fitting the nuts to the pots and

Compression & Distortion Compromises

If we feed a sinewave into the compressor, the amount by which it is distorted depends on its frequency. Lower frequencies suffer much greater distortion. The reason is that for low frequencies, the compressor actually responds to the slow changes in signal amplitude by changing its gain. After all, that is the job of the compressor.

We can reduce the amount of low-frequency distortion by using longer attack and decay times. That way, the compressor doesn't react so quickly to changes in signal level and so low frequencies are passed through more cleanly. But this impacts the function of the compressor and can result in undesirable behaviour, such as obvious "ramping" of the volume level over time. It also limits the extent to which the compressor can deal with sudden, loud sounds such as kick drums or microphone thumps.

So the filter components have been chosen for the best balance between distortion and compression response time. The action of the compressor in dynamically varying its gain inevitably distorts the signal.

In practice, music signals are much more complex than a simple sinewave and the distortion will be lower than the figures suggest.

switch S1 and pushing the two knobs onto the pot shafts. Leave the lid off for the time being – it's attached after the unit has been tested.

Connecting a power supply

The supply connections depend on the type of power supply used:

- If you have a dual-rail (split) DC power supply, connect it to the "+", "0" & "-" terminals of CON5; or
- If you have an AC supply or a single-rail DC supply (eg, a plugpack), connect it to the "+" & "0" terminals of CON5 or feed it in via CON6.

Testing

To test the unit, first apply power and check that the power LED lights. If it doesn't, check the supply polarity and check that the LED is correctly orientated.

Assuming all is well, the next step is to check the power supply voltages on the board. These will vary according to the supply used. For a single-rail DC supply, the voltage between pins 8 & 4 of both IC1 & IC3 and between pins 7 & 4 of IC4 should be at about 15V (note: this will be lower if the DC supply is less than 15V). In addition, the voltage between TP GND2 and TP GND1 should be 7.5V for a 15V supply (ie, half the supply voltage).

Now check the voltage on pin 13 of IC2. It should be at +15V (or less if a lower supply voltage is used).

If you are using a dual-rail supply, the voltages should be measured with respect to the 0V rail at TP GND1. In this case, pin 8 of both IC1 & IC3, pin 13 of IC2 and pin 7 of IC4 should be at +15V. Similarly, pin 4 of IC1, IC3 & IC4 should all be at -15V.

Once again, these voltages will be correspondingly lower if lower supply voltages are used.

Using it

The Stereo Compressor is designed to accept line level signals (ie, 774mV RMS). In addition, level control VR1 must be adjusted so that compressor stage operates correctly, while VR2 functions as an output level (or volume) control.

In theory, VR1 should be set so that there is an average of 1.8VDC between TPL and TP GND1 for a typical signal into the left channel and 1.8VDC between TPR and TP GND1 for the right channel (note: a "typical signal" is the program material that will normally be fed into the unit). It's just a matter of feeding in a suitable signal and adjusting the Level control while monitoring these test points using a multimeter.

If the voltage at these test points is significantly less than 1.8V with VR1 set to maximum, then the gain of op amp stages IC1a & IC1b will have to be increased. This is done by reducing the 10kΩ resistor between pin 2 and ground for IC1a and between pin 6 and ground for IC1b.

Once the signal levels are correct, the unit can be tested by connecting it to an amplifier and feeding in an audio signal. The volume control can then be adjusted to set the output level, while the level control will normally be left unchanged from its previous setting but can be tweaked to alter the compression curve if necessary. SC

Parts List

- 1 PCB, code 01201121, 118 x 102mm
- 1 PCB, code 01201122, 134 x 30mm (front panel)
- 1 PCB, code 01201123, 134 x 30mm (rear panel)
- 1 instrument case, 140 x 110 x 35mm
- 4 PCB-mount single right-angle RCA sockets (CON1-CON4)
- 1 3-way screw terminal block, 5.04mm pitch (CON5)
- 1 PCB-mount DC socket (CON6)
- 1 DPDT PCB-mount right angle toggle switch (S1)
- 2 dual 10kΩ log 16mm potentiometers (VR1,VR2)
- 3 DIP8 IC sockets (optional)
- 1 DIP16 IC socket (optional)
- 1 4-way pin header strip
- 1 2-way pin header strip
- 3 jumper shunts
- 1 200mm length of 0.7mm tinned copper wire
- 4 No.4 x 6mm self-tapping screws
- 6 PC stakes

Semiconductors

- 2 TL072 dual op amps (IC1,IC3)
- 1 SA571N Compandor (available from Futurelec) (IC2)
- 1 TL071 single op amp (IC4)
- 2 1N4004 diodes (D1,D2)
- 2 15V 1W zener diodes (ZD1,ZD2)
- 1 3mm green LED (LED1)

Capacitors

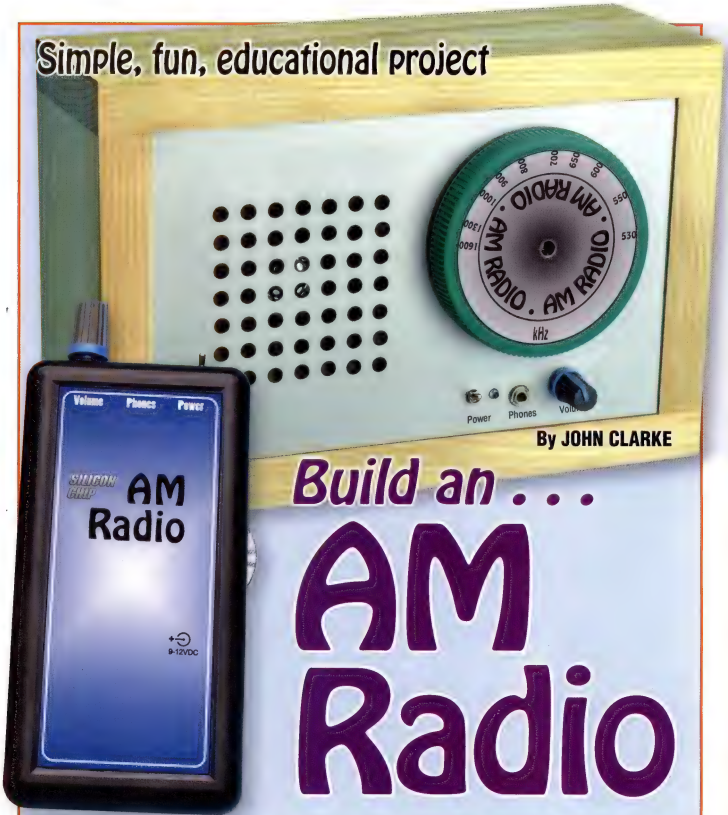
- 2 1000µF 16V PC electrolytic
- 1 100µF 16V PC electrolytic
- 6 10µF NP PC electrolytic
- 9 10µF 35V PC electrolytic
- 2 4.7µF NP PC electrolytic
- 2 2.2µF NP PC electrolytic
- 2 1µF NP PC electrolytic
- 2 1µF 16V PC electrolytic
- 6 470pF ceramic (code 470p or 471)

Resistors (0.25W, 1%)

2 1MΩ	1 4.7kΩ
6 100kΩ	3 150Ω
4 47kΩ	2 10Ω
6 10kΩ	R1, R2 (see Table 2)

Note: all PCBs are available from Silicon Chip Publications.

Simple, fun, educational project



By JOHN CLARKE

Build an . . . AM Radio

This simple AM radio can built in two forms. One is shirt pocket size, not much larger than an Android phone, which drives headphones or ear-buds. The other is a retro-style mantel radio with a hand-span dial and a 100mm (4-inch) loudspeaker in a basic timber cabinet.

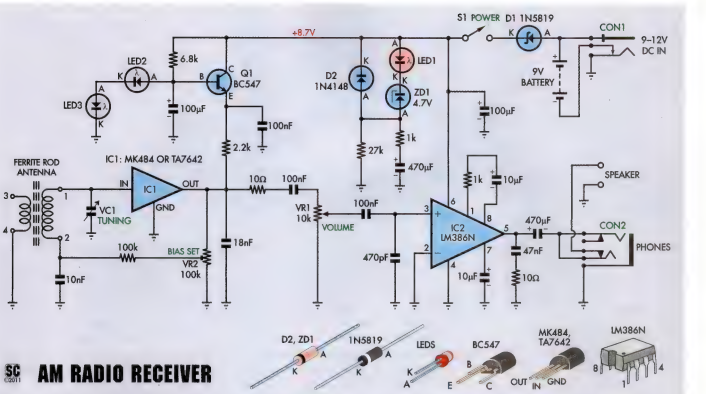


Fig.1: the circuit is based on an MK484 (or TA7642) radio receiver IC. This amplifies and detects the tuned RF signal and drives an LM386N audio amplifier. Q1, LED2 & LED3 provide a regulated 1.4V rail for IC1.

WANT A SIMPLE radio that you, your children or grand-children can easily build? This one uses a small PCB with two ICs and not a great deal more. It's not a superheterodyne so the alignment is very simple and you don't need any special equipment.

The pocket-sized version is housed in a remote-control case incorporating a 9V battery compartment. If you want, there is the option to power it from a 9-12VDC external supply (eg, a plugpack) and to drive an external loudspeaker. It is tuned using a rotary thumbwheel dial and has a volume control, battery condition indicator and power switch.

The retro-style desktop version is designed to look a little like the old AM radios of a bygone era that took pride of place on top of the fireplace mantel. It incorporates a loudspeaker and a hand-span tuning dial. It is housed in a small timber box with an aluminium front panel and this carries the volume control, battery condition indicator and power switch. The sound from the loudspeaker is not overly loud but is quite sufficient for personal listening.

AM radio IC

The circuit for the AM radio is based on a single IC that includes RF (radio frequency) amplification, a detector and AGC (automatic gain control). A similar device was originally available in 1984 from Ferranti Semiconductors and was known as the ZN414Z but is now obsolete. The MK484 replaces this and although out of production, there are remaining stocks. Additionally, the TA7642 is also now available with similar performance to the MK484. These AM radio ICs will work from 150kHz to 3MHz.

Add a tuning coil, a variable capacitor plus some capacitors and resistors and the IC becomes a fully functional AM receiver. For our circuit, the receiver operates over the standard AM radio band of 531-1602kHz. The signal output from the IC is amplified to drive a pair of headphones or a loudspeaker.

We tested both the TA7642 and MK484 in our circuit and found that the TA7642 has greater sensitivity than the MK484. However, its selectivity is wider, ie, it's not as good. This means that the TA7642 will exhibit greater crosstalk (or interference) between stations that have adjacent frequencies. We did not test a ZN414Z as we didn't have one available.

Note that while the performance of this AM Radio Receiver is acceptable, it does not have the selectivity and sound quality that's available from a superheterodyne receiver.

Specifications

Tuning Frequency: approximately 531-1602kHz

Output power: ~300mW into 4Ω

Operating current: typically 27mA

Circuit details

The full circuit for the AM Radio Receiver is shown in Fig.1. IC1 is the AM radio chip. We have reproduced its equivalent circuit in Fig.2 (from the TA7642 data sheet). This is a "tuned radio frequency" or TRF circuit and it combines a high-gain RF (radio frequency) amplifier and a detector, to recover the audio signal. It is not a regenerative or reactive receiver.

The inductance of the ferrite antenna rod (L1) and variable capacitor VC1 form a tuned parallel resonant circuit. This has a high impedance at the tuned frequency and a low impedance at other frequencies.

IC1 amplifies the tuned signal and

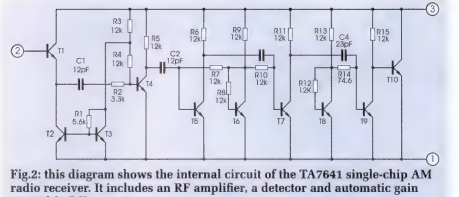


Fig.2: this diagram shows the internal circuit of the TA7641 single-chip AM radio receiver. It includes an RF amplifier, a detector and automatic gain control (AGC) – see text.

then its internal detector rectifies and amplifies the resultant audio frequencies. IC1 is a 3-pin device with its AC output and DC power supply input using the same pin.

One-chip AM radio

The internal workings of IC1 are quite interesting. While it contains 10 transistors (and a number of resistors and capacitors), there are three RF amplifier stages. Transistor T1 is an emitter-follower to provide a high input impedance. T2 is its load and operates as a current sink, biased by T3 and R1.

The signal is then AC-coupled to T4, the first RF amplifier stage. This operates as a common-emitter amplifier with a 12kΩ collector load while transistor T3 also provides its DC bias. The output is then AC-coupled to T5, the second RF amplifier stage. Again it has a 12kΩ collector load and its DC bias is provided by transistor T6. The third amplifier stage, formed by transistor T7 shares the same bias generator.

The output is then AC-coupled to the detector, transistor T9. This is critically biased by transistor T8 (note the low-value resistor from its collector). The result is that it rectifies and amplifies the modulated signal, ie, the audio. This is then amplified and buffered by transistor T10, again a common-emitter amplifier which has its collector connected to the output pin.

The output pin is connected to an external capacitor (18nF in our case) which filters out most of the RF carrier, leaving the original modulating signal which is the audio we want to hear.

That's all relatively straightforward but this chip also includes an automatic gain control (AGC) function and it's less apparent how that operates. The point of AGC is to reduce the amount of RF amplification for strong stations, so that the audio output level doesn't vary too much between strong and weak stations.

While Fig.2 is only an equivalent schematic and so doesn't necessarily show exactly what is going on in the IC, it seems likely the shared biasing arrangement of both T3 and T6 provides this AGC action. With stronger signals, the increased modulation on the later stages causes the bias on the earlier stages to change so that their gain is reduced.

Back to the circuit

While IC1 has internal AGC, its output signal amplitude still varies somewhat with station strength. Trimpot VR2 and its associated 100kΩ resistor allows the overall RF gain (and AGC) to be adjusted to suit the signal strength at your location. When VR2 is adjusted, the DC bias at IC1's input shifts and this changes the bias on its buffer stage and thus the signal level that's fed to the following RF gain stages.

Speaking of the buffer stage, its high input impedance (around 3MΩ) minimises the loading on the tuned circuit, providing optimal operating conditions. The resonant circuit is designed with a high "Q" factor to ensure good selectivity between adjacent stations. This is important because a TRF receiver amplifies whatever signal is picked up and so there is always some risk that strong adjacent stations can "break through".

The supply voltage for IC1 is applied to its OUT terminal and this is derived via transistor Q1 and a 2.2kΩ resistor. The demodulated AM signal also appears at the OUT terminal and the 18nF capacitor to ground rolls off the audio response above 4kHz.

IC1 has a limited operating voltage range of 1.2-1.6V. This is provided by a simple voltage regulator comprising Q1, LED2 & LED3. These two LEDs are infrared types and have a forward voltage of approximately 1V when low current flows through them. This forward voltage is remarkably constant for a wide range of currents. In fact, tests of several infrared LEDs from different manufacturers showed that their forward voltage is around 1.09V at 1.6mA, dropping slightly to 0.945V at 160μA.

Connecting two such LEDs in series provides a reasonably stable 2V reference and these are fed with about 1mA via a 6.8kΩ resistor from the 8.7V supply rail. This 2V reference is applied to the base of transistor Q1 and so about 1.4V appears at its emitter (due to the 0.6V base-emitter voltage drop). This voltage is then used to power IC1 via the 2.2kΩ resistor, as described above.

Audio amplifier stage

IC1's audio output is fed via a 10Ω RF (radio frequency) stopper resistor and a 100nF capacitor to volume potentiometer VR1. The signal at VR1's wiper is then AC-coupled via another 100nF capacitor to pin 3 of IC2, an LM386N audio power amplifier.

The inverting input (pin 2) of IC2 is grounded and the amplifier has a gain of close to 50, as set by the 1kΩ resistor and series 10μF capacitor between pins 1 & 8. The power supply at pin 6 is bypassed with a 100μF capacitor, while a separate 10μF bypass at pin 7 removes supply ripple from the amplifier input stages.

IC2's amplified output appears at pin 5 and is AC-coupled via a 470μF capacitor to stereo headphone socket CON2. This allows either a loudspeaker or a set of headphones to be used. Plugging in the headphones automatically disconnects the loudspeaker.

The 470μF capacitor provides low-frequency roll-off below 21Hz for 32Ω stereo headphones (which are connected in parallel) while for a 4Ω load, the low-frequency roll-off is below 85Hz. In addition, a Zobel network comprising a 10Ω resistor and a 47nF capacitor is connected from IC2's pin 5 output to ground to prevent instability.

Assuming a 9V power supply, IC2 can provide about 300mW into a 4Ω load. Its distortion is typically around 0.2%, rising to 3% at the 300mW level.

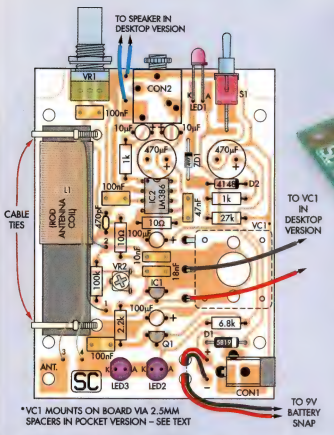


Fig.3: install the parts on the PCB as shown in this diagram. Note that tuning capacitor VC1 is mounted on the PCB for the pocket version only.

This fully-assembled PCB is for the desktop version (ie, VC1 not installed). Take care with component orientation.

The power output is reduced to about 160mW when using 32Ω stereo headphones but this is more than enough to provide sufficient volume.

Power supply

Power for the AM Radio Receiver can come from either a 9V battery or an external 9-12V DC plugpack. When the external supply is plugged into the DC socket, the 9V battery is automatically disconnected. Diode D1 provides reverse polarity protection, while S1 is the power on/off switch.

Note that a 1N5819 Schottky diode is used for D1, to limit the voltage drop across it to about 0.3V.

LED1 is used as a battery condition indicator at switch-on and then functions as a power-on indicator. It operates as follows: when power is first applied, current flows through LED1, 4.7V zener diode ZD1 and a 1kΩ resistor into a 470µF capacitor which is initially discharged. If the 9V battery is fresh, it provides 8.7V at LED1's anode. This voltage is then dropped by about 1.8V across LED1 and by 4.7V across ZD1, leaving 2.2V across the series 1kΩ resistor (ie, when the 470µF capacitor is discharged). As a result, LED1 lights with about 2.2mA initially flowing through it.

At lower battery voltages, there is less voltage across the 1kΩ resistor. As a result, less current flows through LED1 and its initial brightness is reduced. In fact, when the battery voltage eventually gets down to 7V, there is only about 0.2V across the 1kΩ resistor and LED1 barely lights, indicating that the battery has gone "flat".

After switch-on, the current through LED1 is progressively reduced as the 470µF capacitor charges and so the LED quickly dims. It doesn't turn off completely though since the associated 27kΩ resistor ensures that it just remains on, with about 80µA through it. LED1 now indicates that the power is on but the current through it is dramatically reduced to conserve the battery.

When power is switched off, diode D2 discharges the 470µF capacitor so that LED1 is ready to indicate the battery condition the next time the unit is turned on.

PCB assembly

The AM Radio Receiver is built onto

Table 2: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
100nF	0.1µF	100n	104
47nF	0.047µF	47n	473
18nF	0.018µF	18n	183
10nF	0.01µF	10n	103
470pF	NA	470p	471

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	27kΩ	red violet orange brown	red violet black red brown
❑	1	6.8kΩ	blue grey red brown	blue grey black brown brown
❑	1	2.2kΩ	red red red brown	red red black brown brown
❑	2	1kΩ	brown black red brown	brown black black brown brown
❑	2	10Ω	brown black black brown	brown black black gold brown

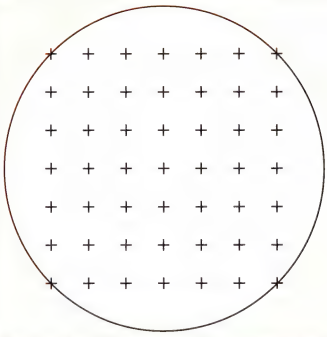


Fig.4: this is the drilling template for the loudspeaker grille in the desktop version. Drill and ream all holes to 5mm.

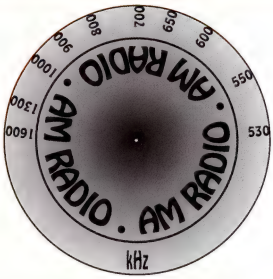


Fig.5: the dial label for the desktop version. It can be downloaded in PDF format from the SILICON CHIP website.

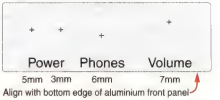


Fig.6: the drilling template and control panel for the desktop version.

The timber cabinet is made from 2 x 238mm and 2 x 120mm lengths of 90 x 19mm dressed pine, with cleats at each corner to secure the front panel.

a PCB coded 06101121 and measuring 65 x 86mm. This PCB is used for both the pocket and desktop versions. The only difference is that for the pocket version, you will need to make the corner cut-outs at one end of the board, adjacent to VR1 and switch S1, to allow the board to clear a couple of pillars in the case. In practice, it's just a matter of using a small hacksaw to cut away the corners and then filing the cut-outs to shape.

Fig.3 shows the assembly details for the PCB. Before installing any parts, check that the corner mounting holes and the holes for the cable ties are all 3mm in diameter. That done, start the assembly by installing the resistors, zener diode ZD1 and diodes D1 & D2. Note that the diodes must all be correctly orientated, as shown on Fig.3.

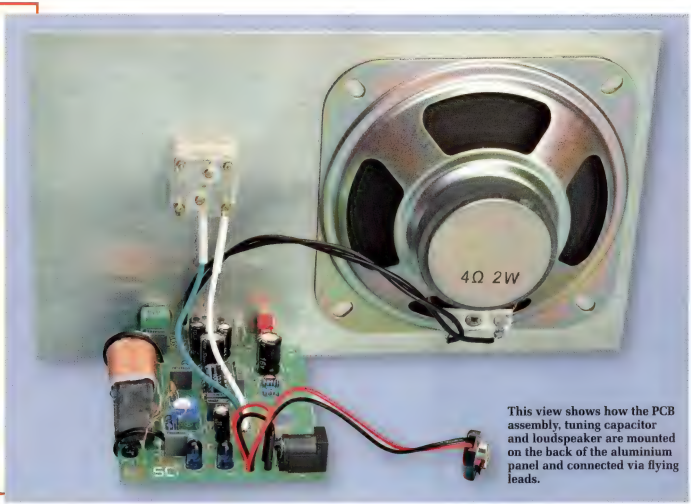
Table 1 shows the resistor colour codes but it's also advisable to check each one using a digital multimeter (DMM) before installing it.

Next, install PCB stakes at the external wiring points, followed by the MKT and ceramic capacitors, then IC1, transistor Q1 and IC2 (LM386N). The latter can either be soldered to the board or you can mount it via an 8-pin IC socket. Make sure that it goes in the right way around.

IC1 and Q1 must also be correctly orientated. Fig.3 shows how to install IC1 if using an MK484 or TA7642 device. **If have a Ferranti ZN414Z in your parts drawer, then this can also be used but note that its GND and OUT pins are reversed compared to the MK484 and TA7642.** This means that it would have to be rotated 180° when installing it on the PCB (ie, install it with its flat side towards Q1).

Installing the LEDs

LED1 (red) is mounted by first bending its leads down through 90° exactly 7mm from its body. It's then installed with the centre of its lens 6mm above the PCB and this can be done by pushing its leads down onto a 6mm-high cardboard spacer. Its anode lead is the



This view shows how the PCB assembly, tuning capacitor and loudspeaker are mounted on the back of the aluminium panel and connected via flying leads.

longer of the two and the LED must go in with this lead adjacent to switch S1.

The two infrared LEDs (LEDs2 & 3) are mounted by pushing them all the way down onto the PCB before soldering their leads (they simply provide a voltage reference for transistor Q1).

The electrolytic capacitors can go in next and these must be orientated as shown on Fig.3. Make sure that the tops of these capacitors are no more than 12.5mm above the PCB if building the pocket version, otherwise the lid of the case will not fit correctly. Once they're in, install potentiometer VR1, trimpot VR2, switch S1, the DC socket (CON1) and the 3.5mm stereo socket (CON2).

Installing the antenna rod

Two 100mm cable ties are used to secure the ferrite rod antenna to the PCB. Once it's in place, separate out the four wires for the two coils and find the two that have the greatest resistance. On our prototype, the main winding on the ferrite rod measured about 10Ω while the separate antenna winding measured 2Ω.

The next step is to connect the coil with the 10Ω resistance to PC stakes "1" and "2". You will find that one of the leads of this winding emerges from inside the coil – this is the wire to connect to PC stake 1. For the rod used in our prototype, it's also the unmarked lead.

The other lead of the 10Ω winding goes to PC stake 2 and this wire will have a blue marking. Connecting the main coil in this way will give the highest selectivity (ie, the highest Q).

The other two wires (ie, in the 2Ω antenna winding) are marked red and green. These go to PC stakes 3 & 4 and can be connected either way around.

Installing VC1

Variable capacitor VC1 is mounted on the front panel in the desktop version and is connected via flying leads (see photo). So, if you're building this version, just solder two 100mm-long lengths of light-duty hook-up wire to VC1's pads for the time being – see Fig.3.

Alternatively, if you're building the pocket version, VC1 is mounted on the PCB itself. **It's not just a matter of installing it flush with the PCB though – instead, it has to be mounted 2.5mm above the PCB using a couple of spacers, so that the tuning thumbwheel doesn't later foul the bottom of the case.** You can use a couple of TO-220 insulating bushes as the spacers and you must secure the assembly using two M2.5 x 6mm machine screws.

Don't use screws that are longer than 6mm, otherwise they will foul the plates inside VC1 and you won't be able to turn the tuning shaft.

The battery clip lead can now be connected to its PC stakes, adjacent to CON1. Be sure to loop the leads through the two strain relief holes in the PCB.

Note that if you are building the pocket version, the battery clip must first placed inside the battery compartment. Its leads are then fed out through a slot at one end and looped through the holes in the PCB.

Desktop version assembly

The case for the desktop version is built using a length of 800 x 90 x

Building The Pocket Version

Above: this is the view inside the completed pocket version but without the battery snap fitted. Note the corner cutouts in the PCB at the top, to clear the case pillars.

Preparing the case that's used to house the pocket version mainly involves drilling its end panel, to provide clearance holes for VR1, CON2, LED1 and power switch S1. The control panel label shown as Fig.7 indicates the drilling details and can be downloaded as a PDF file from the SILICON CHIP website.

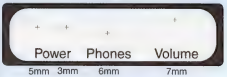
Print the label out, trim off the hole size markings and attach it to the end panel using double-sided adhesive tape. Alternatively, you can print the label onto adhesive-backed photo-paper and attach it directly to the panel. The holes can then be drilled to the sizes indicated. Use a 1mm pilot drill to start each hole, to ensure accuracy.

In addition, you will have to mark out and cut a hole in one side of the case for the DC connector. You can determine the location of this circular cut-out by temporarily positioning the PCB in the case. A rat-tile file is then be used to make the cut-out and you will need to remove material from both the top (mostly) and bottom sections.

A slot is also required in the bottom section for the tuning thumbwheel. The bottom of this slot is flush with the inside base of the case and is 4mm high x 29mm wide, centred on VC1's tuning shaft.

Fig.8 shows the thumbwheel dial label. Print it out and carefully trim it to size before attaching it to the plastic thumbwheel. It must be affixed to the top of the thumbwheel and must be orientated correctly so that the full range of dial markings will be available over the 180° tuning range.

The pocket version assembly can now be completed by slipping the PCB into the case and securing it to the base of the case using four No.4 x 6mm self tapping screws. These go into matching integral mounting pillars in the case. You will also have to fit the battery snap connector (see text) and the front panel label (Fig.9).



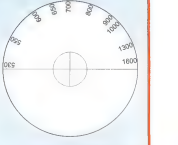
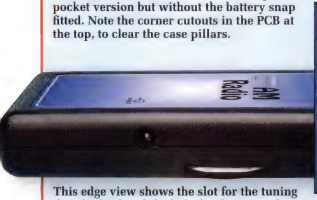


Fig.7 (above) shows the drilling template and control panel for the pocket version while Fig.8 at right is the dial label for the thumbwheel that's supplied with VC1.



This edge view shows the slot for the tuning thumbwheel and the hole for the DC socket.

Fig.9: this is the full-size front panel label for the pocket version.

19mm dressed pine. This is cut into two 238mm and two 120mm lengths and the pieces glued together using butt joints to make a frame (see photo).

A 200 x 120mm aluminium sheet (1mm thick) is used for the front panel. This panel is recessed by 3mm into the timber frame and attached by gluing its inside corners to cleats located at each corner.

Before attaching the aluminium panel, you have to drill the holes for a loudspeaker grille, plus holes for the power switch, LED indicator, headphone socket and volume pot. Fig.4 shows the drilling template for the loudspeaker grille, while Fig.6 shows the front-panel label/drilling template

The large tuning knob used in the desktop version previously served as the lid of a fruit container. It has two timber strips glued to its inside base and the thumbwheel supplied with VC1 is glued to these strips as shown at left.

(also available for download from the SILICON CHIP website). Attach this template to the panel using double-sided tape, with its bottom edge aligned with the bottom of the panel, then drill the holes to the sizes indicated.

Variable capacitor VC1 is also mounted on the aluminium panel. It's just a matter of positioning it so that the 84mm-diameter tuning wheel that's used is clear of the controls and the speaker grille. You will have to drill and ream a 7mm clearance hole for VC1's shaft plus two 2.5mm holes to accept its mounting screws.

Once all the holes have been drilled, glue the aluminium front panel to the cleats, then attach the PCB assembly to the panel and do up the nuts for VR1, CON2 and S1. The mounting holes for the rear of the PCB can then be marked on the wooden base (using the PCB mounting holes as a guide). Carefully measure the locations of these holes, then mark corresponding locations on the outside (bottom) of the case.

Before drilling these holes, remove the PCB assembly to avoid accidental damage. Once it's out, drill two 3mm holes right through the base at the marked locations and countersink these holes by 2mm using an oversize drill – just enough so that the heads of 3mm machine screws fit inside and do not protrude below the surface of the timber.

That done, the PCB assembly is refitted to the front panel and M3 x 6mm tapped Nylon spacers attached to its rear mounting holes using M3 x 5mm screws. These spacers are then secured to the timber base using M3 x 20mm machine screws fed up through the countersink holes.

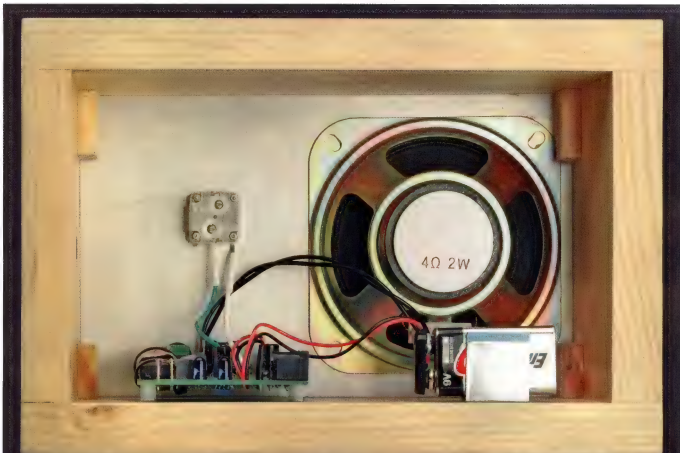
If the top and bottom screws "collide" inside the spacers, fit Nylon or fibre washers under the top screw heads. Alternatively, if the countersinking is too deep, you can fit washers under the bottom screw heads (or you can shorten the 20mm screws).

Tuning capacitor VC1 can now be secured to the front panel using the two M2.5 x 3mm machine screws supplied. It's then fitted with its tuning wheel. For our prototype, we used an 84mm-diameter tuning wheel which previously served as the lid of a plastic fruit container. The small thumbwheel supplied with VC1 is attached to the inside of this lid by first gluing two parallel 4mm-high x 6mm-wide timber strips either side of centre and then gluing the thumbwheel to these using silicone adhesive, as detailed below.

Centring the thumbwheel

It's vital to correctly centre the thumbwheel inside the lid. This is done by first drilling a small pilot hole through the centre of the lid, then enlarging this hole to about 4mm using a tapered reamer. It's then just a matter of visually lining up the centre of the thumbwheel with this hole when the thumbwheel is glued in place.

Be sure to attach the thumbwheel with its collar facing outwards.



This is the view inside the completed desktop version. The rear of the PCB rests on M3 x 6mm tapped spacers which are secured using machine screws. You can either use silicone to secure the aluminium panel to the internal cleats or you can drill holes at the corners and fasten the panel to the cleats using small wood screws.

You should now wait 24 hours for the silicone to set before attaching the tuning wheel to VC1's shaft. The centre hole through the lid provides access to the thumbwheel screw.

Dial label

Fig.5 shows the dial label and this is also available in PDF format from our website. Before affixing it to the lid, rotate the tuning wheel to its centre position. The dial label can then be glued in place with the "kHz" marking at the bottom.

A sharp hobby knife can be used to cut out the centre hole to provide access to the thumbwheel screw should this later become necessary.

Final wiring

The loudspeaker can now be fitted and the wiring run to it and to tuning capacitor VC1. In our case, we used a smear of silicone sealant at each corner to secure the speaker to the rear of the aluminium panel.

Alternatively, you could drill mounting holes through the panel and secure the speaker using M4 x 10mm machine screws, washers and nuts.

You will need to connect the two leads from the PC stakes at the front of the PCB to the speaker. Another two leads run from the PCB to VC1. Note that the centre terminal of VC1 must go the ground connection (ie, the centre terminal for VC1 on the PCB).

Finally, the battery clip holder can be secured to the base using a wood screw. It's optional, however – leave it out if you intend to only power the unit from a plugpack supply.

Testing

To test the unit, apply power and check that LED1 lights when S1 is switched on. If it doesn't, check that the supply leads are the correct way around and that diode D1 and LED1 are orientated correctly. Check also that Q1's emitter is at about 1.4V.

If everything is correct, monitor the output (ie, via headphones or the loudspeaker) and tune in a station. When you find one, adjust trimpot VR2 for best sound quality (ie, for minimum distortion and noise). This trimpot sets the operating voltage at IC1's input so that it operates correctly, without high-frequency oscillation or distortion as can occur if VR2 is adjusted too far clockwise.

On the other hand, adjusting VR2 too far anticlockwise can result in excess noise.

The next step is to make some simple alignment adjustments, so that the receiver covers the correct tuning range. First, if there's a local station at the low-frequency end of the dial (ie, close to 530kHz), check if the station can be tuned in. If it cannot, it will be necessary to adjust the set to give a lower minimum tuning frequency and that's done by sliding the coil towards the middle of the ferrite core.

Alternatively, to obtain a higher minimum frequency (eg, if stations close to 530kHz are coming in too early in the band), slide the coil towards the end of the ferrite rod. The waxed

Parts List

1 PCB, code 06101121, 64 x 86mm
1 9V battery
1 9V battery clip lead
1 miniature PCB-mount SPDT toggle switch (S1) (Altronics S1421 or equivalent)
1 10kΩ log potentiometer, 9mm square, PCB-mount (VR1)
1 100kΩ horizontal miniature trimpot (VR2)
1 knob to suit volume pot.
1 switched 2.5mm PCB-mount DC socket (CON1)
1 PCB-mount 3.5mm stereo socket (CON2)
1 DIP8 IC socket (optional)
1 tuning coil with ferrite rod (L1) (Jaycar LF1020)
1 tuning capacitor 60-160pF (VC1) (Jaycar RV5728)
2 100mm cable ties
8 PC stakes

Semiconductors

1 MK484 single chip AM radio (IC1) (Jaycar ZK-8828) OR 1 TA7642 single chip AM radio (IC1) (Wiltronics X-TA7642)
1 LM386N amplifier (IC2)
1 BC547 NPN transistor (Q1)
1 3mm high-brightness red LED (LED1)
2 5mm IR LEDs (LED2,LED3)
1 4.7V 1W zener diode (ZD1)
1 1N5819 1A Schottky diode (D1)
1 1N4148 diode (D2)

Capacitors

2 470µF 16V PC electrolytic
2 100µF 16V PC electrolytic
2 10µF 16V PC electrolytic
3 100nF MKT polyester
1 47nF MKT polyester
1 18nF MKT polyester
1 10nF MKT polyester
1 470pF ceramic

Resistors (0.25W, 1%)

1 100kΩ	1 2.2kΩ
1 27kΩ	2 1kΩ
1 6.8kΩ	2 10Ω

Extra Parts For Desktop Version

1 aluminium panel 200 x 120 x 1mm
1 90 x 19 x 800mm length of timber (pine or similar)
1 100mm 4Ω loudspeaker
1 84mm diameter tuning dial (eg, the lid from a Goulburn Valley sliced peach plastic fruit container)
1 dial label, 71mm diameter
1 9V battery clip
1 wood screw to secure battery holder
2 M3 x 5mm screws
2 M3 x 20mm screws
2 M3 x 6mm tapped standoffs
1 100mm length of green light-duty hook-up wire
1 100mm length of white light-duty hook-up wire
1 200mm length of black light-duty hook-up wire

Extra Parts For Pocket Version

1 remote control case 135 x 70 x 24mm (Jaycar HB5610 or equivalent)
1 front panel label, 50 x 114mm
2 2.5mm spacers (eg TO-220 insulating bushes)
2 M2.5 x 6mm screws
4 M3 x 6mm screws or No.4 x 6mm self-tapping screws

paper end of the coil former may need to be trimmed if the coil needs to be positioned slightly past the end of the ferrite rod but be careful not to cut the wires.

Now tune to a station at around 1600kHz (if possible). The upper tuning frequency can then be adjusted using the padder capacitor adjustment screw at the rear of VC1 (the one closest to its output pins).

If you don't have stations available at the two frequency extremes (or close to them), then adjust the ferrite rod coil and padder screw so that the stations tune in at the indicated positions on the dial. It's just a matter of adjusting the coil for stations at the low-frequency end of the dial and the padder screw for stations at the high-frequency end until the best compromise is achieved.

Finally, for a full list of AM broadcast stations in Australia see: **http://en.wikipedia.org/wiki/List_of_radio_stations_in_Australia** SC

PRIME ELECTRONICS
Est.1978
customised LED lighting solutions

Wide beam - 60°
Long life - 35,000 hours
Cool operation
Cool, natural & warm white colours
Dimmmable
2 year conditional warranty

5th Generation MR16 LED Replacements

Dimmable using Iron cored transformer and a Clipsal Universal dimmer.

Will operate with most electronic transformers (non dimming).

5W (Dimmable) - 400 lumens
(1+) $24.00 (10+) $22.00
7W (Dimmable) - 460 lumens
(1+) $27.00 (10+) $25.00
9W (Dimmable) - 630 lumens
(1+) $32.00 (10+) $30.00

5th Generation GU10 LED Replacements

Dimmable using Clipsal Universal, Trailing & Leading Edge dimmers.

5W - 400 lumens
(1+) $25.00 (10+) $23.00
5W (Dimmable) - 400 lumens
(1+) $28.00 (10+) $26.00
7W - 460 lumens
(1+) $29.00 (10+) $27.00
7W (Dimmable) - 460 lumens
(1+) $31.00 (10+) $29.00
9W - 630 lumens
(1+) $33.00 (10+) $31.00
9W (Dimmable) - 630 lumens
(1+) $35.00 (10+) $33.00

Queensland
Bowen Hills Ph: (07) 3252 7466
Southport Ph: (07) 5531 2599
New South Wales
Homebush Ph: (02) 9704 9000
www.prime-electronics.com.au

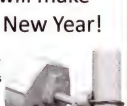
WiFiPRODUCTS

MikroTik

Too hard and too costly to run that data cable?

This will make your New Year!

Work smarter in 2012 by using our SXT 5GHz point to point data link. With this link you can access your LAN from up to 5km away without having to run any CAT5 cables. Easy to install and configure, Very low cost - Just over $200 for both sides, Weatherproof and durable, 200Mbps throughput. Life doesn't have to be difficult this year.



www.wifiproducts.com.au

1800 546 656 (opt 2)

Mikrotik Routerboards, PC Engines, Wireless mini PCI cards, RF cables, VDSL equipment, Point to Point links and more

The famous VAF DC-Series Speaker Kits are back

Just until January 31 and just for Silicon Chip readers (you)

FreeCall 1800 818 882

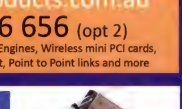
vaf@vaf.com.au

vaf.com.au

VAF RESEARCH

Tech Card

Where Science™ Meets Art



The TechCard System is based upon sturdy, prepunched and scored cards that can be cut, folded and adapted to build working models in the class room or at home.

Tech Card's huge range of kits and instruction material covers: Structures, mechanical linkages, levers, gears, pneumatic control, electric drives and simple electronic systems such as alarms and flashers

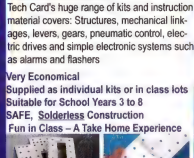
Very Economical

Supplied as individual kits or in class lots

Suitable for School Years 3 to 8

SAFE, Solderless Construction

Fun in Class – A Take Home Experience



Find out more from your TechCard Distributor:

KitStop electronics – the fun starts here

P.O. Box 5422 Clayton Vic.3168

Tel:0432 502 755

www.kitstop.com.au

WIRELESS DESIGN

TEST AND MEASUREMENT

RF COMPONENT SUPPLY	
-Attenuators	-Connectors
-Filters	-Cable Assemblies
-Duplexers	-Couplers
RF EQUIPMENT RENTAL	
-Sitemasters	-RF Power Amplifiers
-Cellular BTS analysers	-PIM Testers
-RF Spectrum Analysers	-RF Network Analysers
RF CALIBRATION	
-Sitemasters	-Signal Generators
-Network Analysers	-Power Meters
-Spectrum Analysers	-DC to 40 GHz
RF CONSULTING	
-Receiver Design	-EMC
-Cellular Coverage	-Passive Intermod
-Cable Analyser Training	
RF TEST EQUIPMENT SALES - NEW AND USED	
-Kaelus PIM Testers	-HP 8920 Test Sets
-RF Power Meters	-RF Sig Gens 40 GHz
-Cable Analysers	-Network Analysers
EMC EQUIPMENT RENTAL	
-RF Immunity Radiated	-Fast Transients
-RF Immunity Conducted	-RF Emissions
-ESD	-Burst Tests

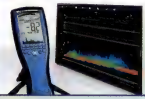
www.wirelessdesign.co.nz

sales@wirelessdesign.co.nz

phone 0276116053 (+64276116053 overseas)

AARONIA AG

Made in Germany; 10 year warranty



RF Spectrum Analysers:
2.5 GHz, 4 GHz, 6 GHz, 8 GHz, 9.4 GHz.
From only $660 including HyperLOG antenna, carry case, mini-tripod/pistol grip, MCS software (Win/Mac/Linux).

HyperLOG antennas:
Broadband, calibrated receive/transmit antennas (100W CW), 2.5 GHz, 4 GHz, 6 GHz, 8 GHz, 10 GHz, 18 GHz. **From only $424 including carry case, cable, mini-tripod/pistol-grip.**

HyperLOG X active antennas:
Active, calibrated receive antennas. 2.5 GHz, 4 GHz, 6 GHz, 8 GHz. **From $1,288 with carry case, cable, mini-tripod/pistol-grip. Optional laser pointer and compass.**

USB RF Spectrum Analysers:
6 GHz, 8 GHz, 9.4 GHz. **From $1,131 including OmniLOG antenna, carry case, MCS spectrum analysis & logging software (Win/Mac/Linux).**

Order online at... www.measurement.net.au

Tel: 1300 726 550

Measurement Innovation Pty Ltd

Screening EMC Antennas | AARONIA AG | EMC-Testequipment Spectrum Analyzer

JOIN THE TECHNOLOGY AGE NOW WITH PICAXE

Developed as a teaching tool, the PICAXE is a low-cost "brain" for almost any project. Easy to use and understand, professionals & hobbyists can be productive within minutes. Free software development system and low-cost in-circuit programming. Variety of hardware, project boards and kits to suit your application. Digital, analog, RS232, 1-Wire™, SPI and I²C.PC connectivity.

Applications include:

- ☑ Datalogging
- ☑ Robotics
- ☑ Measurement & instruments
- ☑ Motor & lighting control
- ☑ Farming & agriculture
- ☑ Internet server
- ☑ Wireless links
- ☑ Colour sensing
- ☑ Fun games

NEW PICAXE Shield kits now in stock!

Distributed in Australia by

Microzed Computers Pty Ltd

Phone 1300 735 420 Fax 1300 735 421

www.microzed.com.au

And now for something completely different . . . Here's something from the past that you will enjoy far into the future!

Radio, TV & Hobbies April 1939-March 1965

Every article to enjoy once again on DVD-ROM

This remarkable archival collection spans nearly three decades of Australia's own Radio & Hobbies and Radio, TV & Hobbies magazines. Every article is scanned into PDF format ready to read and re-read at your leisure on your home computer (obviously, a computer with a DVD-ROM is required, along with Acrobat Reader 6 or later (Acrobat Reader is a free download from Adobe). For history buffs, it's worth its weight in gold. For anyone with even the vaguest interest in Australia's radio and television history (and much more) what could be better? This is one DVD which you must have in your collection!

ONLY $62.00 plus P&P

Only available from ***SILICON CHIP***

See page 79 of this issue for a handy order form

Signal Hound

USB-SA44B Spectrum Analyzer Measuring Receiver

1Hz to 4.4GHz

- The perfect tool for general lab use, electronic engineering students, ham radio enthusiasts and electronic hobbyists alike.
- Phase noise, harmonics, and modulation measurement utilities included.
- Automated test capabilities using API.
- Standard operating temperature range of 0°C to +70°C and optional extended temperature range of -40°C to +85°C.

www.SignalHound.com

SERVICEMAN'S LOG

A repeated & puzzling computer failure

Dave Thompson*

What do you make of a situation where several PCs in an office simultaneously fail for no apparent reason and then replacement machines also fail, along with other gear? It's just got to be a power supply problem but you'll never guess what caused it.

Items Covered This Month

- A real computer mystery
- Diversification is the key
- Corolla door locking system
- Sony STR-K840P amplifier

*Dave Thompson, runs PC Anytime in Christchurch, NZ.

It seems everyone loves a mystery, except of course when it costs money to resolve.

The following events happened to me a few years ago and I still hark back to it to remind myself to think outside the box when confronted with a difficult problem. It all started after we had helped a client move their shipping container operation into new premises in a new industrial estate just out of town.

Their purpose-built building had been cabled and fitted out especially for their particular office set-up and this work had been done in advance on our advice. It made things a whole lot easier for us when it came to setting up their office network and meant that networking two desktop and two laptop computers, several printers and a photocopier took far less time and effort than usual.

By contrast, such moves typically involve trying to figure out how the building has been wired (if at all) and then trying to shoe-horn the client's existing IT infrastructure into it. It's not much fun!

So this move was a breeze, with everything quickly up and running and a gaggle of stressed but happy clients starting to relax as their worries rapidly faded. They had been convinced things wouldn't go as smoothly as we had assured them they would. We'd said all along that with the right planning, it would simply be a matter of unpacking everything at the new office and plugging it in, which is exactly how it all happened.

Unfortunately, it was the lull before the storm. The following morning, when I arrived at the workshop, there was a message on the answering machine asking me to contact them as soon as possible, because "nothing was working". A phone call later I was none the wiser; it was obvious something was very wrong but what they were telling me didn't make any sense. Everything had been working fine the night before but by morning the network has dropped out and to make matters worse, some of the computers wouldn't boot properly.

I did my best to convince the client that this sort of thing was relatively normal and that teething problems were to be expected with any new major IT installation, especially if it involves moving into a new building. The client seemed sympathetic but I could tell that the afterglow of the previous day's success was now significantly less rosy.

Not just the computers

I duly arrived on-site to find an alarm technician checking out the door and window sensors and a puzzled-looking telephone technician poking and prodding the controller box with one of those red-handled, insulated-shaft screwdrivers they all seem to use. My client and his staff were sitting at their computers trying to "see" each other on the network but having no joy while the alarm "beeped" annoyingly every few seconds just to add to the already tense atmosphere.

The team insisted that everything had been going fine when they left the previous evening. However, when they had arrived this morning, this was how they found things, with the alarm and phones not working properly (hence the technicians looking busy) and the computers either not starting at all or shutting down randomly by themselves. So what had happened in the meantime?

It sounded to me like a power "event" had taken things out and that's the road I started down. After all, we were stuck out in an industrial wasteland, with likely grubby mains power supplies and dozens of factories nearby with whopping great machinery starting and stopping all hours of the day.

I decided then and there that regardless of what we discovered, I would recommend my client install a UPS (uninterruptible power supply) for each workstation and maybe even for the peripherals. It's something we wouldn't usually do due to the added cost and besides, the mains power supply is usually pretty stable – discounting the odd earthquake that is!

When I broached the subject with the other technicians present, they looked at me like I had just suggested aliens had landed, so I left them to their own devices. I had more pressing issues to deal with, such as getting the client's computers up and running so they could conduct their daily business.

Unfortunately, that wasn't going to be easy; only one of their four machines booted to the operating system and it wasn't the "main" machine. The main machine was a desktop unit that we had designated as the "server". It

had all their vital data files on it and it was refusing to boot.

After giving it a quick once-over, I diagnosed a faulty motherboard and that meant that possibly the CPU and/or the memory had also failed. And while we had decent back-up (last carried out just before the shift), I hoped that the data drive was still intact so that we wouldn't have to scramble to put everything back together. Theoretically, all I needed was another similar (if not identical) box. I could then "throw" the data drive from the failed machine into it and get things back up and running relatively quickly.

But of course, it wasn't going to be that simple. There's always a "gotcha".

The "gotcha" in this case was that I couldn't touch any of these computers because they were leased from a local retailer and they had the say on any repairs. This was frustrating because my client had previously turned down an excellent quote from us for a system in favour of leasing lower-spec hardware from one of our competitors.

It meant that my clients were now dead in the water and there was nothing I could do but advise they either take the computers in for repair or try to get someone out to do it as soon as possible. However, I could see that getting someone out would be a waste of time because they'd have to take the machines back to their workshop anyway.

It was at this point that my client began to lose the distinction between where my services ended and the other company's began. My advice didn't go down too well and pressure was applied for me to "fast-track" some repairs in order to speed things along. In other words, couldn't I do something since I was already on the premises? And couldn't I take the computers to my competitors to get them fixed since I knew what was wrong?

My answer was a firm "no"; there was no way I was going to turn up at a competitor's workshop with computers they'd supplied and besides, I'd been caught out before. Out of a sense of loyalty to another client on a previous occasion, I took a look at one of their leased computers. That machine turned out to be fried and since I'd removed the cover to take a look inside (there were no seals to break), the lessor tried very hard to fit me up for the machine's failure.

Fortunately, they didn't succeed but that particular episode taught me an extremely valuable lesson – never put myself in a position to be the patsy.

And so, while my client got on the by-now-working phone to the other company, I revisited the other two technicians. The phone guy had somehow "reset" his system to get it going, though he couldn't say what had caused it to fail in the first place.

By this stage, the other technician had also killed the annoying beeping noise from the alarm, which lifted the atmosphere in the office considerably. After testing the sensors and cabling he'd come to the conclusion that the main control panel was knackered and he would have to replace it.

As a result, they were now a lot more inclined to accept that a power event was responsible but what type of event? Was it a lightning strike? Or maybe a car had tangled with a power pole in the vicinity? There was nothing to suggest that anything like these events had occurred, so it was all a mystery.

In the end, we agreed that it might be prudent to get a "sparky" out to check things over, just to be sure. The client agreed to this and decided to wait for the electrician's report before looking into adding a UPS to each workstation.

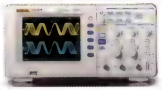
By that time I'd done about all I could do and once I'd made sure that the other company had been brought up to date, I went back to my workshop. Over the next few days I checked in frequently and eventually learned that the computer people had ended up replacing all the machines in the office. And at that point, they wanted me to go back out and set them all up on the network, as before.

By all accounts, things had been relatively OK although the alarm had gone off a few times over the previous few days and the phones had again played up. It was thought that these events were related since the alarm was monitored via the telephone line.

It didn't take long to complete the network set-up and the client was happy once again and ready for business. But having been caught once, he wanted a quote for supplying and installing the UPSs.

Australia's Best Priced DSOs

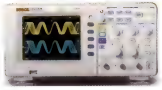
Shop On-Line at emona.com.au



RIGOL DS-1052E 50MHz

- 50MHz Bandwidth, 2 Ch
- 1GS/s Real Time Sampling
- USB Device, USB Host & PictBridge

ONLY $439 inc GST



RIGOL DS-1102E 100MHz

- 100MHz Bandwidth, 2 Ch
- 1GS/s Real Time Sampling
- USB Device, USB Host & PictBridge

ONLY $769 inc GST

RIGOL DS-1202CA 200MHz

- 200MHz Bandwidth, 2 Ch
- 2GS/s Real Time Sampling
- USB Device & USB Host

ONLY $1,422 inc GST

Sydney
Tel 02 9519 3933
Fax 02 9550 1378

Melbourne
Tel 03 9889 0427
Fax 03 9889 0715

email testinst@emona.com.au

Brisbane
Tel 07 3275 2183
Fax 07 3275 2196

Adelaide
Tel 08 8363 5733
Fax 08 8363 5799

Perth
Tel 08 9361 4200
Fax 08 9361 4300

web www.emona.com.au

EMONA

Well, all was quiet on the western front for a few days and then I arrived at work one morning to another phone message saying that things were no longer working. Either this was a glitch in the matrix of the universe or something else very odd was going on. The "deja vu" continued when I got back out there to find the phone and alarm technicians scowling into their respective systems.

Something had taken out the alarm and phones again and while the phones were quickly restored, the alarm board again needed to be replaced. Only two of the four computers had copped it this time but the network was down along with the internet.

I immediately suspected the router and testing showed it to be faulty. That was immediately replaced and that got the remaining working machines and other peripherals online. The two faulty computers would again have to be dealt with by the other company.

By this time the client was getting a little annoyed and was insisting that I get to the bottom of the problem. After all, hadn't we advised them on the set-up during the building phase? Perhaps we had missed something?

Well, to be honest, I hadn't helped set up a building in quite this way before, so I started thinking that there might be something to his claims. Nobody else in the neighbourhood seemed to have any problems, so why just this building? There had to be something unique that was causing things to burn out but what?

When the faulty machines were replaced I was again called out to set them up on the network. During this work, I noticed that my client had obtained UPSs – they had been supplied by the other company and I was taken aback that they had again gone elsewhere. However, it was their decision and if the issues they were having were power related, then these units should help.

Another week went by and when I heard nothing back, I gave the company one of our usual "follow-up" calls to see how things were progressing. This time, the client curtly informed me that someone else had now sorted the problem and he went on to politely thank us for our past services, so we were now getting the brush-off. However, I was still curious to know what had happened so I asked the question.

It turned out that as part of their new range of services, the company had become involved in cutting up and modifying shipping containers to make portable offices, sleep-outs and other structures. And in order to carve these steel behemoths into something useful, the company had invested in a massive new plasma cutter, which they used every couple of nights when the night shift reported in.

The problem was that every time they fired this thing up, either the electromagnetic radiation or back-EMF or something similar was walloping the power system and frying the hardware. It had somehow been wired incorrectly (I never did find out how) and eventually someone had twigged that it was only when they used the cutter that the computers got hammered.

Of course, I previously had no idea that this thing even existed, so I couldn't very well factor it into the mix of possible causes for the computer failures. However, it all serves as a very good lesson; when tasked with working out an especially curly problem, leave no stone unturned and ask as many questions as you can. It's sometimes the only way you can gather enough facts to make a proper diagnosis!

Diversification is the key

An odd thing about running a computer repair company is that clients often bring in peripherals such as printers and monitors to be repaired as well. This means we have to deal with a wide range of technologies if we are to repair such items and the learning curves can be steep.

Many repair companies out-source this type of repair because they either don't have the resources available or they don't know how these things work and aren't interested in finding out. But the reality these days is that the computer repair business is an ever-shrinking market; machines are far more reliable than they used to be, they are much easier to set up and the kids coming out of schools are far more computer-literate than any other generation before them.

It means that work that was once the mainstay of many computer repair companies can now be done by some 13-year old. And if the teen runs into problems, the answers to whatever questions they might have can often be found on-line.

An important ingredient established businesses can offer clients is credibility and service. Diversification is the key and you need to offer a wider range of services than just removing viruses, doing basic PC repairs and installing operating systems.

What the majority of customers are really looking for is service and value. Adding value to any service may be as simple as calling a week after the job has gone out and asking how things are going, or doing something over and above what the job called for without charging for it, eg, cleaning dust out of a computer or cleaning the keyboard and screen on a laptop. These simple acts can turn a client into a loyal customer.

Another way to add value is to diversify into the likes of printer and monitor repairs and data recovery services. Printers are a good example. There are really only two different basic types: ink/bubblejet and laser. While each brand has its own particular methods and technologies, each type operates in much the same way.

Servicing Stories Wanted

Do you have any good servicing stories that you would like to share in The Serviceman column in SILICON CHIP? If so, why not send those stories in to us? In doesn't matter what the story is about as long as it's in some way related to the electronics or electrical industries, to computers or even to car electronics.

We pay for all contributions published but please note that your material must be original. Send your contribution by email to:

editor@siliconchip.com.au

Please be sure to include your full name and address details.

Basic servicing and maintenance can easily be carried out and spares can often be ordered in from any of the specialist printer repair outfits around town. It's also often beneficial to partner with such companies because they get clients bringing in computers for repair as well as printers and they can then send these clients to you, while you can send on printer repairs that are beyond your servicing scope.

Replacing the likes of ink pads, print heads and even selling cartridges can be very profitable, not to mention giving clients something more to look at and impulse buy when they are standing in your reception area!

Monitors are a little different but like printers, replacement boards and even screens are often available, once again from agents and importers keen to open up another revenue stream. Any that are too far gone to repair can be replaced, so you may get a hardware sale just by offering the repair service.

Powered door lock

My next story comes from G. B. of Essenden, Vic., who finally got sick of manually locking his car after the power locking failed. Here's how he fixed it . . .

Our 1996 Corolla's driver's door power lock hadn't worked for a number of years. When it first started to malfunction, it was sluggish in operation and while it worked reasonably well when the weather was cold, it was slow to operate when warmer. The other locks would pop up quickly but the driver's door lock seemed to work in slow motion.

Eventually, it failed to work at all, so we just used the key to lock and unlock the door rather than the remote fob. This went on for some years until finally I decided that it was time to see if something could be done about it.

Once I'd removed the inside panel and unplugged the window and door-lock switches, I was faced with the door innards behind a moisture barrier. The black stuff they use to stick the barrier on is formidable (even after 15 years) but I eventually got enough away without damaging it too much, so that I could examine the door lock.

Prior to removing that panel, I had pictured the remote locking bits as something similar to the door locking kits from Jaycar but this proved to be far from reality. The door lock motor is built into the lock itself and there are four levers made from what looks like oversized coat hanger wire, all bent in a particular way to reliably operate the lock. I have to say, it is a clever piece of kit with one lever for the inside door opener, one for the button that pops up and down, one for the outside key lock and one for the outside door handle opener.

At first, you wonder how they get it all in there, as it is all mounted in a metal cavity. The trick was to undo the heavy screws from the outside that hold it in place against the inside of the door. Once this is done, it drops down and you then have to apply several contortion techniques to unhook the wire levers. It took quite some time and a few unsavoury words to get it free.

Once it was on the bench, I cleaned it up with turps and then took a look to see how it worked. There are four wires coming out of the lock – red and black for the motor and blue and white from a position sensor which determines if the door is locked or unlocked. The motor drives a spring-loaded cog via a worm wheel. This cog in turn operates a cam that locks and unlocks the lock, depending on the polarity applied to the motor.

The motor and gears are encased in an enclosure and are accessed by undoing a few screws to remove the cover. When I applied power to the motor, it worked but it didn't have enough grunt to operate the lock. I was surprised at this, as I had expected the motor to have failed completely.

Next, I removed the motor from the enclosure and applied power again. It turned freely but when I loaded it by squeezing the shaft with my fingers, it slowed and stopped. I then let the shaft go and it remained stopped, so the problem was in the motor itself.

I could see that the brushes at one end of the motor could be easily removed by prising open a couple of tabs. That done, I cleaned the commutator and brushes, reassembled it and tried it again. This time it seemed to work better but when I applied a load on the shaft, it stopped again. As a result, I took another look at the brushes and this time I took more notice of the strange arrangement used to feed the positive brush.

The negative brush was fed directly from the terminal but the positive (red) one had what looked like a rectangular piece of metal about 8 x 10mm inserted in series with its lead. It wasn't soldered, so I pulled it out. One face is copper, the other an aluminium-like metal, and sandwiched in between is some black stuff. Altogether, it's about 1mm thick and I guessed that it was some sort of resistor that increased in value as it got hotter, ie, a positive temperature coefficient resistor.

I connected it to my meter and placed my soldering iron on it and sure enough, the resistance increased from zero to some figure that I didn't take much notice of. My conclusion was that this part was most likely faulty. In fact, it had probably been below specification right from when the car was new since it didn't take long for the problem to show up.

I found a piece of aluminium the same thickness as the faulty PTC resistor, cut it to size and slipped it into place in the motor. And with every-

Sony STR-K840P 5.1 Channel Amplifier

P. W. of Hope Valley, SA recently encountered a problem with his Sony STR-K840P surround sound amplifier. Here's how he tells it . . .

After eight years of faithful service, my Sony STR-K840P 100W 5.1 channel amplifier/receiver suddenly started misbehaving. It began by intermittently causing loud clicks and thumps to be heard from the speakers, with the symptoms progressively becoming more frequent over the next few days.

What was a little strange was that the clicking could also be triggered if I bumped the case. Eventually, the whole unit stopped working, with a "Protect" message appearing on the display.

This model has speaker anti-thump/protection relay circuits for each of the five surround outputs. And when the protect mode operates, all outputs are opened until the power is reset.

The fact that the problem could be triggered by vibration indicated that a dry joint (or joints) could be the cause. To begin with, I did some research on the net and managed to find a circuit diagram. As in many such units, the output stages use high-current bipolar transistors in a push-pull arrangement.

Next, I opened the case and began the disassembly, being careful to record each step, including what ribbon cables went where and the screw sizes and locations. Inside, the unit looked like it had just left the factory. Everything appeared in mint condition, with surprisingly little dust.

After about half an hour, I managed to remove the main circuit board and place it upside down on my workbench. Using an illuminated magnifying glass, I went over the board, paying particular attention to the high current connections around the output transistors.

Nothing seemed out of the ordinary so I checked the resistance of the 0.22Ω emitter resistors. These proved to be OK, so I then fired up the soldering iron and touched up all the heavy current connections, hoping that that would fix the problem.

After reassembly and switch on, it was clear that the problem had not been fixed. Much to my annoyance, that nasty "Protect" message was still being displayed.

Unwilling to waste any more time on the unit, I decided that I might be better off buying a new amplifier. Some research on the net indicated a range of about $400 to $1000 for a comparable unit to replace the Sony. However, while I was surfing, I entered a search for "dry joints" for my existing model and lo and behold, a hit appeared. The entry was very brief but it talked about dry joints around IC501.

A look at the circuit diagram revealed that the front and rear speaker output power output stages are driven by a pair of UPC2851 stereo power ICs (IC701 and IC702), while the centre speaker is driven by an STK350-230 mono power IC (IC501). If there were dry joints on any of these items, then that would certainly upset the output stages.

Armed with that information, I dismantled the unit once more and took a close look at the joints around each of these ICs. And there was the problem, staring me in the face. How could I have not seen the telltale circular solder joint fractures around many of the pins on these ICs during my first inspection of the circuit board?

The answer of course is that I had been so focussed on the heavy-current connections that I had overlooked these IC pins.

The re-soldering job took just a few minutes and after reassembling the unit, that nasty "protect" message was gone and the unit performed like new again. It not only gave me the satisfaction of another successful repair job but saved me a substantial amount of money into the bargain.

thing re-assembled, the lock worked as it should although the motor was now connected directly to 12V. The resistor is a safety feature that prevents the motor from burning out if it becomes jammed, so I couldn't just leave it like that.

One option was to buy a new lock assembly but it would probably be expensive, as spare parts for cars usually are. Alternatively, I could try buying the assembly from a wreckers or I could try to fix it myself.

In the end, I decided I'd have a go at it myself before I went down the wreckers path. As a result, I went a local auto parts store and bought a 12V bayonet fitting and some brake/tail lights. Light globes exhibit a similar characteristic to PTC resistors – ie, they increase in resistance as the filament gets hotter – so I thought that if I connected one in series with the motor, this would provide the necessary current limiting if the door-lock motor jammed.

I connected the 21W filament of a globe in series with the motor and the lock seemed to operate OK, so I refitted it to the door. This involved a reversal of the contortion techniques used to get the thing out. However, there was a plastic protection cover that I couldn't install while reconnecting one of the levers at the same time, so in the end I just left it out!

I used cable ties to secure the globe in open space inside the door cavity and once it was all installed, I tried operating it with the fob. This time, the lock wouldn't quite work. You could see it trying to operate but again, it didn't have enough grunt. The globe was lighting but the car's ECU only applies a short negative or positive pulse to operate the lock.

Basically, the globe was heating too quickly and robbing the motor of sufficient current to operate the lock. In the end, I wired another holder fitted with a 21W globe in parallel with the first globe and it then all worked correctly. The globes now only just come on when the lock operates and if the motor does happen to jam, then the current will be limited to about 4A, with the globes shining brightly. SC

Happy New Year 2012

BETTER, MORE TECHNICAL

More NEW products inside!

BIG BOYS NEW TOYS

NEW

We have a massive range of easy to fly action packed helicopters that provide hours of fun over the holidays.

More helicopters available instore

- 3 channel, 27MHz
- Gyroscope for stable flight
- Li-Po helicopter battery
- 120 min charge for 8 min flight time

Large 3D Full Function RC Helicopter

- Strong aluminium frame
- Remote requires 6 x AA batteries
- Size: 775mm long

GT-3360

$99.95

Advanced Single Blade RC Helicopter

- Remote requires 6 x AA batteries
- Size: 390mm long

GT-3490

$99.95

SMART DIGITAL PEN FOR iPHONE® AND iPAD®

NEW

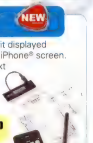
Write or draw on paper and see it displayed simultaneously on your iPad® or iPhone® screen. Sketch images, graphs, write text with it and saved digitally at the same time. Stores up to 100 pages in the memory and can work standalone.

- MAC and PC compatible
- Pack includes: sensor pen, USB cable, receiver and spare ink for pen

XC-0359

$169.00

iPhone® not included



UPS WITH LCD & USB

Protect your computer equipment with these robust uninterruptible power supplies. They strike a good balance between real time system protection and power redundancy where mains electricity is down or unreliable. A steady voltage is delivered during voltage sags and in the event of total power blackout your systems will run long enough (10 - 20mins) to shut down cleanly. Both models feature easy to read LCDs which show battery and load values as a percentage and input/output voltages.

Two models available.

NEW

650VA/390W
MP-5205 $179.00

1500VA/900W
MP-5207 $349.00

From **$179.00**

MOTION SENSOR ALARM WITH VIDEO RECORDING

This 2-in-1 motion sensor alarm with an inbuilt video camera, records up to 2 hours of video/audio onto the included 4GB SD Card. Incorporates battery backup power for staying armed during night time and the solar panel provides sufficient power for standby use during the day. Supplied with infrared remote control and AV cable to watch the recorded footage directly on your TV.

Alarm:

- 12 IR LEDs
- Supports up to 32GB SD Card (1GB Records 30 mins)
- Size: 116(H) x 70(W) x 33(D)mm

Colour Camera:

- Image Sensor: CMOS
- Resolution: 480 TV lines
- Pixels: 640(H) x 480(V)
- Batteries included

QC-8016

NEW

$99.00

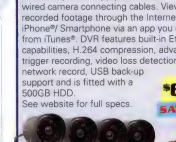
NETWORK DVR KIT WITH 4 IR CAMERAS

Multiplexing DVR system that comes complete with four weatherproof IR outdoor CCD colour cameras, power supply and four 20 metre pre-wired camera connecting cables. View live or recorded footage through the Internet or an iPhone®/ Smartphone via an app you can download from iTunes®. DVR features built-in Ethernet capabilities, H.264 compression, advanced motion trigger recording, video loss detection, remote network record, USB back-up support and is fitted with a 500GB HDD.

See website for full specs.

$649.00

SAVE $200



More NEW YEARS Savings on page 3

- 4 channel with VGA output and inbuilt multiplexer
- Camera: 420 TV Lines
- DVR Size: 343(W) x 59(H) x 223(D) mm
- Camera Size: 116(L) x 60(W) x 79(H)mm

QV-8104 WAS $849.00

Limited Stock. Not available online.

Includes 500GB HDD

CAMERA DETECTOR

Detect covert cameras and listening devices with this handy little unit. It uses 6 pulsing LEDs to reveal the location of a camera by illuminating its lens when you look through the lens viewer from up to 10m away. Earphones supplied.

NEW

- Built-in wireless RF detector
- Signal strength indicator
- Requires 2 x AAA batteries (use our **SB-2426** $1.95)
- Size: 85(H) x 56(W) x 18(D)mm

QC-3506

Due early January

$99.00

WHITE ACTIVE COLUMN SPEAKERS

NEW

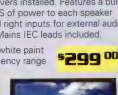
Provide excellent directivity through the three 4" full range drivers installed. Features a built in amplifier, 20WRMS of power to each speaker and has RCA left and right inputs for external audio source connection. Mains IEC leads included.

- Finished in glossy white paint
- 70Hz - 15kHz frequency range
- Voltage: 240VAC
- Size: 532(H) x 113(D) x 131(W)mm
- Sold as a pair

CS-2439

$299.00

Ideal for pubs, clubs, auditoriums etc.



TV not included

STEREO COMPRESSOR KIT

NEW

Refer: SC Magazine Jan 2012

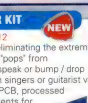
Compressors are useful in eliminating the extreme sound levels during TV ads, "pops" from microphones when people speak or bump / drop them, levelling signals when singers or guitarist vary their level, etc. Kit includes PCB, processed case and electronic components for 12VDC operation. 12VDC plug pack required - use MP-3147 $17.95.

KC-5507

$59.95

NEW Year Kit!

Due Late January



PRO GAS SOLDERING TOOL KIT

A sturdy, portable, self-igniting butane powered gas soldering iron tool kit. Produces a 1300°C adjustable flame for low end brazing, tin/plastic melting, automotive repair work, welding and of course heat shrinking. Supplied with 3 interchangeable metal tips, plastic carry case, cleaning sponge and deflector.

$69.95

- 80-100 min operating time
- Torch dimensions: 236(L) x 37(D)mm

TS-1113

More DIY tools on page 7

NEW

Spare tips & butane gas available separately.
See in-store or online for more details.

AUTOMATIC BLOOD PRESSURE MONITOR

An easy way to monitor your own blood pressure and heart rate. Uses the oscillometric method to take accurate blood pressure readings from the wrist and calculates the average as well as storing up to 3 readings.

- Includes 2 x AAA batteries
- Arrhythmia detection function (IHB)

NEW

NOTE: This is not a medical diagnostic device and is intended to provide indicative readings only. It should be used in conjunction with advice from a doctor or other clinical professional.

QM-7254

$49.95

Prices valid from 26/12/2011 to 23/01/2012. Limited stock on sale items. No rainchecks.

To order call **1800 022 888** www.jaycar.com.au

Jaycar Electronics

Better, More Technical

New Year, New Products

SECURITY PRODUCTS

Motion Sensor Alarm with Solar Panel

Armed or disarmed with 4 digit security code using the built in keypad. Secures an area of up to 8 metres with it's built in motion sensor which triggers the siren once movement is detected. Incorporates battery backup power for staying armed during night time and solar panel provides sufficient power for standby use during the day.

NEW

- Backup battery: 3 x AA batteries (not included)
- Mounting hardware included
- Size: 116(H) x 70(W) x 33(D)mm

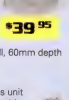
$19.95

LA-5216

Recessed 360 degree PIR Presence Detector

NEW

A passive infra-red presence sensor switch for lighting energy saving applications. This 360 degree PIR has a 5 metre coverage which is recessed ceiling mounted and has a 75mm diameter. Adjustable time delay and light level control function. For indoor use only.



$39.95

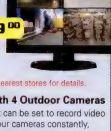
- Voltage: 240VAC 50Hz
- Size: 62mm cutout, 75mm overall, 60mm depth

LA-5049

19" LCD Security Monitor

Unlike most other LCD screens this unit features a hardened front panel capable of withstanding a massive impact without shattering. Features BNC/VGA/HDMI inputs for easy connection to your DVR or media player. Suitable for installation in exposed areas such as pubs or clubs.

NEW



- Resolution: 1280 x 1024
- Size:455(W) x 360(H) x 60(D)mm

$469.00

QM-3576

Special order only. Call your nearest stores for details.

4 Channel DVR Kit with 4 Outdoor Cameras

Digital Video Recorder that can be set to record video from its four day/night colour cameras constantly, scheduled or when motion is detected. Uses H.264 video compression to store over 300 hours of video on its 500GB hard drive, which can be viewed live or played back on a TV, computer monitor or accessed over the Internet (with password protection) using a standard web browser or Smartphone/iPhone® app*. Four 18m cables, remote control and power supply included.

NEW

DVR Features:

- Real time monitoring
- Backup to external USB drive
- Alarm notification by email
- Up to 704 x 576 pixel resolution
- Size: 300(L) x 210(W) x 50(H)mm

Camera Features:

- Colour CMOS 350TV lines
- Outdoor weatherproof enclosure
- Infrared LEDs for night illumination

$649.00

QV-3028

NOTE: *FREE application available to view live footage. Application based searching and backup requires advanced version at an additional cost.

IT PRODUCTS

2.4GHz Wireless Keyboard & Mouse

An all-in-one wireless keyboard and mouse solution perfectly suited to home or office PC applications. Features Qwerty keyboard and an ergonomically designed precision mouse with scroll wheel.

NEW

- Batteries included
- Operating range: Up to 10m
- Size: 435(L) x 125(W) x 18(H)mm

$24.95

XC-5174

Also available: **NEW** Mini Wireless Keyboard with Trackball **XC-4943** $49.95

USB MINI INSPECTION CAMERA

Use your laptop as a monitor and you have a compact inspection camera for checking of termites and other rodents, insulation, finding lost tools etc. The camera is only 10mm diameter and has two variable intensity LEDs for illuminating the area under examination, and has a 7m long cable to allow you to get into the deeper places that can't be reached with a shorter cable.

NEW

$59.95

QC-3371

Due early January

DOUBLE ADAPTOR WITH NIGHT LIGHT

Leave a night light on for the kids without wasting a power point. When the lights go out, the light comes on so you can find your way to the little room or the kitchen for a midnight snack.

- 0.2W power
- Light-sensitive
- Size: 88(H) x 44(W) x 33(D)mm

NEW

$9.95

PP-4039

WIRELESS DOORBELL ALARM

A wireless doorbell suitable for the elderly or hearing impaired. A flashing blue light accompanied with 1 of 36 selectable melodies is used when the doorbell button is pressed. An alerting sound with a flashing red light is activated once the alarm transmitter is used. Supports count down timer or an alarm clock function.

- Transmission range 80 metres line of sight

LA-5022

NEW

$34.95

Due early January

STEREO INNER EAR EARPHONES

Jaycar offers a new range and variety of stereo earphones, from budget to high quality earphones to suits your needs.

NEW

- Speaker diameter: 10mm
- Frequency range: 20Hz - 20kHz
- Max power input: 10mW

From $5.95

Budget Stereo Earphones	**AA-2090** $5.95
Metal Stereo Earphones	**AA-2092** $9.95
High Quality Stereo Earphones	**AA-2094** $24.95
Stereo Earphones with Built-in Mic	**AA-2096** $9.95

Mini DisplayPort to VGA Converter

Connect modern computers with a Mini DisplayPort to a conventional VGA display, such as CRT, LCD monitor or projector. Mini DisplayPort offers a unified, scalable, and cost effective interface for embedded and external display applications.

NEW

- Mini DisplayPort 1.1a compliant
- Supports up to 1080p, 1920 x 1200 video resolution

WO-7440

Also available:
Mini DisplayPort to HDMI Converter **WO-7442** $29.95
Mini DisplayPort to Video Converter **WO-7444** $29.95

$29.95

BRIGHT BICYCLE REAR SAFETY LIGHT

- 5 super bright LEDs
- Up to 150 hour run time
- 6 light modes
- Mount using multi-purpose bracket or belt clip
- Quick release bracket
- 2 x AAA batteries required

ST-3061

NEW

$9.95

RC PRODUCTS

Mini High Speed RC Stunt Car

Designed for thrills and spills with two protection rings that act as a roll cage. Supplied with a remote control & launch pad for stunt jumps.

NEW

- Requires 6 x AA batteries (remote & charger)
- 30 min charge for up to 9 mins play
- Size: 105mm long

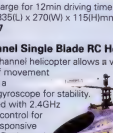
$19.95

GT-3293

1:12 Scale High Speed RC Truggy S800

Features precision steering system, multiple shock positions with front and rear fully independent suspension. Up to 18km/h top speed with sensational driving performance and agility with a 4WD shaft drive and extra large volume shocks for optimal handling. The high-grip tyres are designed for maximum traction ideal for sharp corner turns and up scaling hills. 2V 1100mAH Ni-MH rechargeable battery included. Suitable for ages 14+.

NEW



- 4hr charge for 12min driving time
- Size: 335(L) x 270(W) x 115(H)mm

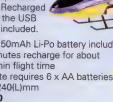
$79.95

GT-3687

4 Channel Single Blade RC Helicopter

This 4 channel helicopter allows a wider range of movement and has a built in gyroscope for stability. Equipped with 2.4GHz remote control for more responsive control. Recharged through the USB charger included.

NEW



- 3.7V 150mAh Li-Po battery included
- 55 minutes recharge for about 7-10 min flight time
- Remote requires 6 x AA batteries
- Size: 240(L)mm

$79.95

GT-3430

New Year Savings

SAVINGS ON TOYS

Mini Apache 2-Ch IR Helicopter

33% OFF

Robust moulded plastic construction.

- 20 minute charge for about 10 minutes flying time
- Recharges directly from the remote unit
- Size: 160(L)mm approx.

GT-3273 WAS $29.95

$19.95 SAVE $10.00

Limited stock. Not available online.

Kid's Digital Photo & Video Camera

50% OFF

Robust shockproof design. 16MB internal memory, it can capture up to 120 still photos or 50 seconds of video.

- Camera driver software and USB cable included
- Recommended for ages 3+

QC-3188 WAS $49.95

$24.95 SAVE $25.00

Limited stock. Not available online.

1:12 Scale Casey Stoner Moto GP Ducati

A replica of Casey Stoner's 2007 Moto GP Championship-winning 800cc Ducati with full function digital proportional remote control.

- Steering trim alignment
- Brake endpoint adjustment
- Size: 175L/mm

GT-3690 WAS $99.00

Limited stock. Not available online.

$59.00 SAVE $40.00

40% OFF

MASSIVE Savings Over 50% OFF!

More specials in-store. Contact your nearest store for details.

COMPACT USB MEDIA PLAYER AND CONTROLLER

57% OFF

Cue, play, manipulate and even scratch digital files. Supports external USB mass storage devices up to 80GB. See our website for full specifications.

- DSP effects
- Size: 204(W) x 215(H) x 93(D)mm

AA-0499 WAS $349.00

$149.00 SAVE $200

Limited stock.

38 CHANNEL CB RADIO

Lightweight hand-held transceiver suitable for all professional and recreational activities. Transmission range is up to 5km, with city range up to 1km.

- Covers Australian 38 UHF CB channels and repeaters
- Size: 105(H) x 60(W) x 35(D)mm

DC-1023 WAS $49.95

Limited stock. Not available online.

$24.95 SAVE $25.00

50% OFF

DOCK RECORDER FOR IPOD®

Record and encode stereo audio MP3 straight to your iPod®. Simply connect an audio source to the dock and record via the voice/memo recording mode.

- Mains plugpack included
- Size: 100(L) x 100(W) x 35(H)mm

AA-0498 WAS $119.00

58% OFF

iPod® not included

$49.00 SAVE $70.00

Limited stock.

USB DESKTOP STATION

Charges multiple items at once such as your mobile phone, iPod®, PDA and other USB devices. It keeps workspace free from messy USB leads. Comes with 8 connectors compatible with major brand mobile phones.

- Size: 230(L) x 230(W) x 40(H)mm

MB-3640 WAS $29.95

$19.95 SAVE $10.00

33% OFF

SAVINGS ON TEST EQUIPMENT

Cat III Dynamo-Powered DMM

Just crank the handle for 10 seconds to provide power for approx 10 minutes operation. Ideal for electrical emergencies on the car or boat.

- Display: 4000 count
- No batteries required
- Size: 152(L) x 78(W) x 45(D)mm

QM-1547 WAS $79.95

$39.95 SAVE $40.00

50% OFF

Wireless 3-Outlet Mains Power Meter

Simply plug an appliance into each sender unit, enter local electricity price and monitor the usage on the LCD receiver unit.

40% OFF

- Clock and alarm function
- Display greenhouse gas emissions in kg
- Transmission range: 30m

MS-6116 WAS $99.95

$59.95 SAVE $40.00

Limited stock. Not available online.

SAVINGS ON SCANNERS

Portable A4 Scanner

13% OFF

Capture A4 documents or images straight to MicroSD card. No PC or software required. 2 x AA batteries provide about 180 scans.

- Built-in LCD shows scanning status with selected resolution, battery life, and memory status
- Micro SDcard and batteries not included
- Size: 256(L) x 30(W) x 31(H)mm

XC-4909 WAS $149.00

$129.00 SAVE $20.00

USB Combo Image Scanner with LCD

25% OFF

Convert old images to digital image format. Connect this to your PC and take high resolution scans of all your photos, slides and negatives to preserve in JPEG or TIF format.

- 2.4" LCD preview panel
- Size: 210(L) x 230(W) x 150(H)mm

XC-4893 WAS $199.00

$149.00 SAVE $50.00

DVR KITS WITH COLOUR CAMERAS

FREE extra camera (QC-3239) valued at $59.95

30% OFF

Suited to small surveillance installations, this 4 channel systems can store over 150 hours of video on the internal 320GB HDD. View the recorded video in an indexed event log via a computer or external monitor. Complete with weather resistant IR cameras, cables, remote control and mains adaptors.

- MJPEG compression
- SATA hard drive interface
- CMOS sensor, 350TV lines
- Inbuilt infrared illumination for day/night operation
- Spare camera available

QC-3239 $59.95

QV-3020 WAS $499.00

$349.00 SAVE $150

Limited stock. Not available online.

GOOSENECK USB CMOS INSPECTION CAMERA

Offers a wide array of applications including checking under vehicles, inside cupboards, behind wall cavities, inside engines, up chimneys etc. Completely portable and powered by USB.

- Software drivers and magnetic attachment included
- LED illuminators

QC-3388 WAS $59.95

33% OFF

$39.95 SAVE $20.00

Limited stock. Not available online.

Automotive Accessories

NEW Year Savings!

TRAVEL COMPANION

7" TFT LCD Colour Monitor with IR Remote

A truly versatile monitor with low power consumption, wide viewing angle and NTSC and PAL compatibility. Use it to watch DVDs, PS2®, XBOX®, etc. Unit comes with an adjustable swivel bracket with double sided tape. Features two RCA composite video inputs and one audio input for a multi source system. Infrared remote control included.

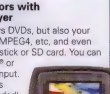
- Power input: 12VDC
- Resolution: 1140(H) x 234(V)
- Inbuilt speaker
- Reverse image capability

QM-3752 WAS $159.00

$119.00
SAVE $40.00

7" TFT Colour Monitors with Headrest & DVD Player

This system not only plays DVDs, but also your video files such as DivX, MPEG4, etc, and even play videos on your USB stick or SD card. You can also connect an Xbox360® or Playstation3® via the AV input. Includes an in-built games system (games CDs included), two games controllers and IR remote control.



- Resolution: 1440 x 234 (16:9/4:3 selectable)
- System: NTSC/PAL
- Power: 12VDC
- Dark grey leather-look upholstery
- Supports infrared earphones
- Supports USB/MS/MMC/SD card
- Headrest dimensions: 280(W) x 200(H) x 110(D)mm

QM-3776 WAS $229.00

$199.00
SAVE $30.00

7" TFT Colour Monitor with Headrest

If you already have a DVD player or other video source in the car, such as the QM-3776 (above) you can set this up as a second or third monitor as part of system. This model features a 7" TFT screen, with two composite video inputs and IR remote control and is identical in appearance to the QM-3776 - making them an excellent "pair" for a complete in-car video entertainment system.

- 2 composite video inputs
- Headrest dimensions: 280(W) x 200(H) x 110(D)mm

QM-3766 WAS $189.00

$139.00
SAVE $50.00

REVERSING LED LIGHT WITH WARNING BUZZER

NEW

Replacement LED reversing light with built-in warning buzzer to warn pedestrians that you are reversing. Suits vehicles with P21W BA15S reverse light bulbs.

- 9 Super Bright White LEDs
- Input voltage: 9 - 12VDC

ZD-0511

WARNING: Some state and road authorities may not allow retrofitting of reverse lamps - even if it is easy to do so.

$9.95

RESPONSE CAR AMPLIFIERS

With improved heat sinks and upgraded low-profile chassis design, each model delivers surprising grunt and performance in a sleek and compact package that fits neatly under your car seat. All include gold plated power and speaker terminals and variable low pass filters. Plus our class AB amps come with variable high pass filters and pass through RCAs; while our class D subwoofer amps feature variable subsonic filter, phase shift and master/slave operation.

RESPONSE

AA-0452

From **$119.00**
SAVE **$30.00**

		WAS	NOW	SAVE
2 x 80WRMS Class AB	AA-0450	$149.00	$119.00	$30.00
4 x 50WRMS Class AB	AA-0451	$199.00	$149.00	$50.00
2 x 150WRMS Class AB	AA-0452	$229.00	$169.00	$60.00
4 x 100WRMS Class AB	AA-0453	$299.00	$229.00	$70.00
500WRMS Linkable Class D	AA-0454	$249.00	$199.00	$50.00
1000WRMS Linkable Class D	AA-0455	$369.00	$299.00	$70.00
4 x 100WRMS Full Range	AA-0457	$349.00	$299.00	$50.00

COMPACT FUEL CELL ALCOHOL TESTER

A fuel cell provides greater accuracy, readings with better reliability and is the technology used by law enforcement for years. Just blow in the mouthpiece for a reading in seconds. Requires 2x AAA batteries (use **SB-2426** $1.95)

$119.00

- Backlit LCD
- Pk10 spare mouthpieces (**QM-7303** $4.95)

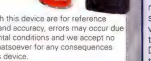
NEW

QM-7302

NOTE: Readings taken with this device are for reference only. In spite of its quality and accuracy, errors may occur due to operation or environmental conditions and we accept no liability or responsibility whatsoever for any consequences arising from the use of this device.

DOOR LOCK ACTUATORS

Durable, waterproof and dustproof with Japanese mechanics, and supplied with universal mounting hardware. Wiring not included.



- Input voltage: 9 - 16VDC

Slave Door Lock Actuator
- Door lock actuator used on passenger doors.

NEW

LR-8813

Master Door Lock Actuator
- Door lock actuator for Driver's door. Includes microswitch output to activate power lock relay LR-8818.

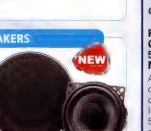
LR-8815

$14.95

Also available: Power Lock Relay **LR-8818** $14.95

KEVLAR CAR SPEAKERS

Back by popular demand and with a more competitive price! These are our ever popular Response Precision Kevlar Coaxial Speakers that has won many awards and magazine recommendations. The speaker cone is now supplied in black and tweeters are still the original soft dome tweeter that provides clean, crisp sounds and maintains a natural and smooth balanced sound.



NEW

4"	CS-2400	$69.95
5"	CS-2401	$79.95
6.5"	CS-2402	$89.95
6 x 9"	CS-2403	$119.00

From **$69.95**

AUTO REVERSING KITS

Wireless Digital Vehicle Parking Assist System

This 4 sensor reversing system utilises a wireless connectivity between the monitor and the sensors of up to 30 metres making it suitable for larger vehicle installations such as trucks, buses, motor homes, caravans, etc. Distances from objects are accurately displayed on the 5 colour LCD display as well as voice and beep alerts.

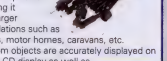
$129.00

- Power: 12VDC

LR-8874

2.4GHz Wireless Reversing Camera and LCD Monitor

The LCD on this unit plugs straight into your car's cigarette lighter socket and receives video via 2.4GHz wireless band from the reversing camera. The camera can be mounted internally through the rear window or externally on the number plate or bumper. Transmission range is up to 80m suitable for very large motorhomes, trucks or caravans.



- 3.5" built-in LCD
- Power: 12VDC
- Size: 110(W) x 76(H) x 21(D)mm

QM-3796 WAS $199.00

$179.00
SAVE $20.00

Reversing Camera with 5-inch LCD Monitor

Affordable all-in-one reversing camera kit. Includes a slimline 5" LCD monitor, a powerful suction mount bracket, and a tiny reversing camera to be mounted at the rear of the vehicle. The camera docks securely in the bracket but can be easily popped out and put in your glove box so as not to tempt potential thieves.

$249.00

- Dimensions:
  LCD: 127(L) x 82(W) x 15(D)mm
  Bracket: 133(H) x 65(Dia.)mm

QM-3741

All Savings are based on Original RRP. Limited stock on sale items.

Camping & Outdoors

SOLID LED LIGHT BARS FOR 4WD/MARINE

These solid LED light bars are your alternative to the typical "driving lights" installed on the bull bars and roll bars of utes and 4WDs. Features extremely high light output (up to 3600 lumen), completely waterproof (IP68), shock proof and have 100% optically clear polycarbonate front lens cover. Each model is supplied with alloy mounting feet, stainless steel hardware, and a wiring harness with remote rocker switch and relay.

NEW

From $199.00

- 50,000+ hour life span
- 9-32VDC input (24V systems will need 12V relay replaced with 24V item)
- Seoul Semiconductor LEDs

4" with 8 LEDs
SL-3912 $199.00

10" with 20 LEDs
SL-3914 $419.00

190 LUMEN CREE® LED POWERED TORCH WITH ADJUSTABLE LENS

With a massive light output of 190 lumens, a tactical switch and multiple light modes every 4WD should have one in the glovebox

- Adjustable beam
- Requires 3 x AAA batteries
- Size: 105(L) x 27.5(Dia.)mm

ST-3456

Buy 2 for $50 SAVE $19.90

$34.95

MINI WIRELESS WEATHER CENTRE

Keep up-to-date with current and forecasted atmospheric conditions at a glance. With two small wireless outdoor weather sensors, it measures, records and forecasts all the basic weather parameters and displays them on an LCD screen. Handy features include three forecast icons based on changing barometric pressure (Min, Max and history records.

$79.00 SAVE $20.00

- LCD screen: 135(W) x 34(D) x 140(H)mm

XC-0349 WAS $99.00

Also available: Rain Gauge Sensor to suit **XC-0347** $39.95

Buy XC-0349 & XC-0347 for $99 Save $39.95

WATER FUN ACTIVITES

30m Underwater Luxeon LED Powered Diving Torch

Encased in a tough, chemical resistant and corrosion proof fluorescent yellow body and will blast out 250 lumens of white light. Includes a carrying strap and ripple handle for maximum grip and comfort. Requires 2 x C batteries.

- 1 x Luxeon Rebel 100 White LED
- Burn time: 35 hrs (max output)
- Size: 182(L) x 89(W)mm

ST-3459 WAS $29.95

$24.95 SAVE $5.00

Diving Mask with Digital Camera 2GB

Strap on this diving mask with a built-in digital camera and you can take up to 2350 photos or 2 hours of video. Features tempered glass lenses, durable frame and a silicone mask gasket.

- Rated for 15m depth
- LED flash
- 5MP sensor
- 2GB internal memory
- 3 hour battery life

QC-3186 WAS $129.00

$89.00 SAVE $40.00

POWERTECH MONOCRYSTALLINE SOLAR PANELS

A range of efficient solar panels with reliable performance and robust construction using tempered glass and aluminium frame. Sizes range from 5W to 175W. Fitted with Junction box. See website for more info.

- 25 year limited warranty

		WAS	NOW	SAVE
12V 5W	ZM-9091	$27.95	$22.95	$5.00
12V 10W	ZM-9093	$49.95	$42.95	$7.00
12V 20W	ZM-9094	$99.00	$85.00	$14.00
12V 40W	ZM-9095	$185.00	$159.00	$26.00
12V 65W	ZM-9096	$299.00	$269.00	$30.00
12V 80W	ZM-9097	$339.00	$289.00	$50.00
12V 120W	ZM-9098	$499.00	$425.00	$74.00
24V 175W	ZM-9099	$729.00	$619.00	$110.00

From $22.95 SAVE $5.00

8A 12V WATER RESISTANT PWM SOLAR CHARGE CONTROLLER

NEW

This solid state charge controller is suitable for both wet-cell and sealed lead-acid batteries and uses pulse width modulation for optimal 3-stage charging. Features dusk-till-dawn night light load output, different charge modes for wet and sealed lead-acid batteries, low voltage battery protection, and a whole host of other features. See our website for full specifications.

- Size: 97(L) x 46(W) x 26(H)mm

MP-3720

$49.95

12V MODIFIED SINE WAVE INVERTERS

Take your creature comforts with you when you're out and about this summer. These modified sine wave inverters produce 230VAC from your vehicle's battery with sufficient power to run anything from a battery charger to power tools.

From $49.95

150W	MI-5102	$49.95
300W	MI-5104	$69.95
400W	MI-5106	$99.00
600W	MI-5108	$169.00
800W	MI-5110	$199.00
1000W	MI-5112	$299.00
1500W	MI-5114	$449.00

Pure sine wave inverters also available. See in-store or on website.

SOLAR EQUIPMENT

Portable Fold-Up Solar Panel Kits

Perfect for the summer camping, 4WD, or boating trek. These fold away solar panels will connect to your existing 12V battery to run power or lighting wherever you are.

- All models include alligator connections on a 4m lead, charge controller, a heavy duty metal carry handle and latches plus protective plastic corners.

From $279.00

Massive Savings!

		WAS	NOW	SAVE
40W	ZM-9132	$399.00	$279.00	$120.00
80W	ZM-9130	$549.00	$479.00	$70.00
120W	ZM-9134	$899.00	$699.00	$200.00

Solar Ecotech Mounting Hardware

Mounting system for attaching solar panels to the roof of your property. Designed to be used with either tiled or tin roofs and with any slope.

- Vertical or horizontal panel mounting
- Suitable for aluminium framed panels
- 10 year materials warranty

NEW

From $3.95

Rail 2560mm	HS-8800 $49.95
Rail 3405mm	HS-8801 $69.95
Rail 4200mm	HS-8802 $84.95
Rail Splice	HS-8803 $9.95
End Clamp 35mm	HS-8804 $3.95
Mid Clamp 35mm	HS-8805 $3.95
Tile Roof Hook	HS-8806 $26.95
Tin Roof Hook	HS-8807 $8.95
Adjustable Tilt Front Leg	HS-8810 $15.95
Adjustable Tilt Back Leg 10-15°	HS-8811 $39.95
Adjustable Tilt Back Leg 15-30°	HS-8812 $49.95
Adjustable Tilt Back Leg 30-60°	HS-8813 $59.95

Not available to all stores but can be ordered. Call your nearest store for details.

Jaycar Electronics

DJ Essentials

DJ PARTY EQUIPMENT

USB Turntable with MP3 Encoding

Converts your LPs into MP3 files to your USB memory stick. Simply play your records, plug your USB device in and click record. Finished in chrome and black.

- 2 speed belt drive turntable
- Anti-skating control
- Motor off and reverse function
- RCA Phonoline output
- Size: 449(W) x 145(H) x 370(D)mm

AA-0494 WAS $249.00

$199.00 SAVE $50.00

2 Channel MIDI Mixer with Virtual DJ Software

Mix, play and scratch your own MP3 tracks directly from your PC. The mixer sends MIDI data from the controller to your DJ software without the inconvenience of mouse control. It's fully class-compliant USB MIDI device and complete with Virtual DJ software. See our website for full features and specifications.

- 2-deck controller
- Mix 2 files in 1 controller
- USB powered
- Size: 358(W) x 260(H) x 45(D)mm

AM-4252 WAS $299.00

$249.00 SAVE $50.00

Dual Channel/Bridged Rack Mount Amplifiers

Add a small mixer and use them as a PA amp, or standalone as a foldback amp. They have 1/4" jack inputs, balanced XLR and line-level RCA inputs. They can be run as dual channel, stereo or bridged. Excellent build quality, solid aluminium chassis and front panels.

- Fan cooled
- Separate level controls for each channel
- Clipping and overload protection indicator LEDs

200W AA-0477 Now: $179.00 Save: $20.00
400W AA-0479 Now: $279.00 Save: $20.00

From **$179.00** SAVE $20.00

LED LINKABLE PARTY LIGHTS WITH CONTROLLER

Inject some life into the party with these linkable blue, amber and red LED party lights. They'll switch in time with the beat and the microphone sensitivity and light chaser speed are fully adjustable. Mains powered and designed to last. Two models available:

3 LED SL-2911 $49.95
6 LED SL-2913 $79.95

From **$49.95**

2 X 15WRMS PORTABLE STEREO AMPLIFIER

NEW

This compact amplifier can run off 8 x AA batteries (not included) making it ideal for street performers, or by the included AC adaptor for a Hi-Fi setup at home or in the office. Outputs 15WRMS per channel and features spring-loaded push terminals and rear mounted 3.5mm stereo audio input. Includes a 1.8m 3.5mm cable to connect to a PC, iPod®, MP3 player, etc.

- Size: 150(W) x 130(D) x 30(H)mm

AA-0487

$49.95

RAVE FOG MACHINE

Creates an amazing ambience by producing clouds of fog on demand. Pair it with laser light shows, mirror balls and other party lighting for full effect.

- Size: 330(L) x 160(W) x 140(H)mm
- 1L Spare Fog Juice - **AF-1212** $17.95

AF-1214

NEW 20ml Strawberry fog scent for fog juice available

AF-1211 $14.95

$99.95

MINI ULTRA-VIOLET FLUORO LANTERN

Ultra violet fluoro lantern rated at 4W is ideal for use in small spaces. Small, lightweight and requires 4 x AA batteries. Includes small spot light and hand carry strap. Also great for security ID checks.

- Size: 160(L) x 52(D) x 23(W)mm

SL-3146

$14.95

NEW

12W DMX REVOLVING LED LIGHT

Features advanced moonflower effects with high power red, green, blue and white LEDs with colour changing and colour mixing beams. With 7 Channel DMX-512 programming or linking capabilities, built-in sound modulator, a step motor for smooth movement and strobe speed adjustment.

- 7 DMX Channels (Colour, Rotation, Rotation Speed & Strobe/Dimmer)
- Control mode: Sound Active, Master/Slave or DMX-512
- Mains Powered
- Size: 216(W) x 196(H) x 135(D)mm

SL-2899

DMX controller also available **SL-3429** $149.00

$169.00

DMX LED MOVING HEAD SPOT LIGHT

This compact, lightweight and cost effective 15W RGBW LED moving head spot light integrates a user selectable 540 degree pan and 270 degree tilt, it has 9 gobos plus open and wheel spin effect. With 14 DMX channels, it features variable electronic strobe and dimmer functions. LED light with up to 50,000 hours of service.

- Built-in movement macros
- Built-in fan cooler
- Bracket and 240VAC mains power supply included
- Size: 249(H) x 173(W) x 173(D) mm

SL-3440

$349.00

DMX CONTROL KITS

DMX Relay Control Kit

Control a relay with the DMX-512 protocol. The relay will be activated when the DMX value of the set channel equals 140 or more and turns off when the value is 120 or less. Team it with KV-3610 (below) to make a computer-controlled automation system. Short form kit.

- 512 unique addresses, DIP switch settable
- LED indication for power supply, relay output and error status
- Relay hold function in case of DMX signal loss

KV-3612 WAS $49.95

$39.95 SAVE $10.00

DMX Control Dimmer Kit

Allows you to control a lamp or group of lamps through a DMX signal. You can use the USB Controlled DMX Interface kit (KV-3610 below) or any other control console compliant with the DMX-512 protocol as a controller. It will drive resistive loads like incandescent lamps and mains voltage halogen lighting. Shortform kit.

- 512 unique addresses, selectable with DIP switch
- Status LED for power and error detection
- Stand alone mode for testing

KV-3614 WAS $79.95

$69.95 SAVE $10.00

DMX Controller USB Interface

This kit controls DMX fixtures such as spotlights using a PC and USB interface. It can also be operated in stand-alone mode that outputs all 512 channels at the same time (9V battery required for stand-alone mode). Includes software, USB cable and enclosure.

- Test software and DMX Light Player software included
- 512 DMX channels with 256 levels each
- 3 pin XLR-DMX output connector

KV-3610 WAS $149.00

$129.00 SAVE $20.00

MONITOR YOUR POWER & SAVE

Mains Wireless Power Monitor

With the sensor unit installed in your fuse box, household power usage data is wirelessly transmitted to the indoor display unit up to 50m away. Scrutinise week-to-date and year-to-date energy consumption. LCD receiver and sensor unit each run on 2 x AA batteries (included).

- Electricity usage (watts), cost and time displayed
- Suitable for single phase only
- Dimensions: Display unit: 101(H) x 80(W) x 42(D)mm Sensor unit: 75(L) x 60(W) x 35(H)mm

MS-6160 WAS $99.95

$79.95 SAVE $20.00

Mains Power Monitor with USB Interface

This unit will monitor the energy consumption of an entire home to determine how much electricity an appliances uses. Displays power, cost, CO_2 and temperature with a transmission range of up to 40m.

- Uses 433MHz to wirelessly transmit data
- Display unit uses mains adaptor or 3 x AAA batteries
- Includes 2 x D batteries for transmitter

MS-6165 WAS $139.00

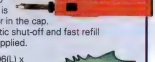
$119.00 SAVE $20.00

Hobbyist Tools

SOLDERING TOOLS

Portasol 50 Gas Soldering Iron

Powered with standard butane gas, it has a run time of around 30 minutes. Ignition is via the flint igniter in the cap. Features automatic shut-off and fast refill time. 1mm tip supplied.



$24.95

- Dimensions: 196(L) x 26(W) x 19(D)mm

TS-1300

FREE 1mm Tip (TS-1301) valued at $9.95

Tips to suit available. See in-store or on website.

Metal Desolder Tool

This quality desolder tool is made from lightweight metal and has strong suction.

- Constant vacuum force
- Automatically cleans itself with each action
- Total length including tip - 195mm

TH-1862

$16.95

FREE 1mm Tip (TH-1863) valued at $4.95

Lead-Free Solder

99.3% tin, 0.7% copper lead-free. Sizes for every application from hobby to industry.

0.71mm

12g Hobby Pack	NS-3086 $2.95
200g Roll	NS-3088 $17.95
500g Roll	NS-3090 $42.00

1mm

15g Hobby Pack	NS-3092 $2.95
200g Roll	NS-3094 $17.95
500g Roll	NS-3096 $42.00

From **$2.95**

GOOSENECK MAGNIFIER

This handy hobbyist's magnifier has a 2 x main magnifier lens with 5 x insert lens and 2 LED lights, all mounted on a flexible arm. Can be free-standing or clamped to a surface up to 38mm thick. Comes with a soft protective pouch for your lens to protect it from dirt and dust.

$29.95

- Lens 110(Dia.)mm
- Stands 225mm high
- Requires 3 x AAA batteries (use **SB-2413** $3.95)

QM-3532

RETRACTABLE 3M ALLIGATOR TEST LEAD SET

Set of 3 heavy duty red, black, and green leads on a retractable 3m reel, terminated with insulated alligator clips.

- Reel Dimensions: 152(Dia.) x 20(W)mm

WT-5334

$24.95

LOW COST DMM

This is a full featured meter with plug-in 4mm probes and transistor tester. Ideal first multimeter and will give years of faithful service.

$9.95

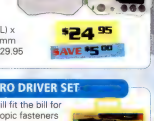
- Display: 2000 count
- Category: Cat II 500V
- Transistor and diode test
- 10A DC current
- Size: 125(H) x 68(W) x 23(D)mm

QM-1500

Buy 2 for $15 Save $4.90

110 PIECE 12V ROTARY TOOL SET

Drill, saw, sand, polish, carve or grind with this comprehensive rotary tool set. Rated 12V and runs at 12,000 RPM and with over 100 bits and attachments you'll be able to cover every task imaginable. See website for full list of attachments.



- Case size: 240(L) x 200(W) x 70(D)mm

TD-2451 WAS $29.95

$24.95 SAVE $5.00

15 PIECE MICRO DRIVER SET

This handy set will fit the bill for all those microscopic fasteners we come across in modern electronics. The ergonomic handles are colour coded for easy identification and comes in a sturdy storage case. See website for full list of drivers.

- Drivers: 105mm long
- Case size: 192(L) x 130(W) x 26(H)mm

TD-2069 WAS $24.95

$19.95 SAVE $5.00

60W LEAD-FREE SOLDERING STATION WITH LCD PANEL

This excellent soldering station is particularly suited to lead-free soldering and is just as capable with ordinary leaded solder. The soldering pencil is fitted with a soft insulated rubber grip and has a silicon rubber sheathed power cable. Mains operated.

- Power: 60W
- Digital LCD display
- Microprocessor controlled
- Temperature range 160°C to 480°C
- Size: 130(L) x 170(W) x 240(H)mm

TS-1390 WAS $179.00

$159.00 SAVE $20.00

Conical tips available. See in-store or on website.

PROJECT TOOLS

Wire Stripper

A great way to strip all sorts of cable without damaging the conductors. It automatically adjusts to insulation diameter.

- One hand operation
- Spring return

TH-1824

$16.95

Bull Nose Plier

This high quality miniature combination bull nose plier is made from hardened carbon steel with a micro-nickel finish. The handle has a matt red vinyl coating.

- TUV and GS approved
- 120mm / 4.5" long

TH-1889

$8.95

Stainless Steel Side Cutter

High quality small side cutter with 2mm thick blades and comfortable soft plastic spring loaded handles.

- 115mm long

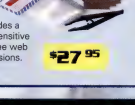
TH-1890

$13.95

HOBBYIST ESSENTIALS

PCB Etching Kit

An ideal kit for anyone needing to etch a circuit board - complete with an assortment of double-sided copper boards, etchant, working bath and tweezers. It also includes a positive acting photosensitive PCB and developer. See web site for full list of inclusions.

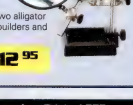


HG-9990

$27.95

PCB Holder with Magnifying Glass

An extra pair of hands and eyes for those fiddly jobs. Supports PCBs while soldering etc. Features 90mm magnifying glass and two alligator clips. Great for model builders and other hobbyists.



- 145mm high

TH-1983

$12.95

PC Boards - Vero Type Strip

Alphanumeric grid, pre-drilled 0.9mm, 2.5mm spacing.

- 95mm wide x 3 handy lengths

76mm	HP-9540 $4.50
125mm	HP-9542 $7.95
303mm	HP-9544 $11.50

From **$4.50**

Digital Ready

HD DIGITAL TV SET-TOP BOX

Digital and HD ready. This compact set top box unit receives Crystal clear free-to-air digital TV in high definition. Incorporates a USB port for AV program recording as well as playback. Outputs are HDMI, component video and composite video. Remote control included.

$69.95
SAVE $10.00

- Digital and HD ready
- Selectable aspect ratio 4:3/16:9
- Remote requires 2 x AAA batteries
- Size: 220(W) x 140(D) x 42(H)mm

XC-4917 WAS $79.95

HDMI RETRACTABLE LEADS 1.3M

A comprehensive range of connecting cables Concord that set the standard for quality, performance and value. ATC certified and is fully V1.4 compliant.

NEW

- Pure digital connection
- Ultra fast signal
- Advanced technology connection
- Sealed moulded connectors
- Ethernet channel
- 1.3m length

$24.95 ea

HDMI Plug to HDMI Plug	**WC-7740** $24.95
HDMI Plug to HDMI C Plug	**WC-7742** $24.95
HDMI Plug to HDMI D Plug	**WC-7744** $24.95

900MHZ WIRELESS STEREO HEADPHONES WITH FM RADIO

Designed to receive high-quality stereo sound from any audio devices such as computer, TV, Hi-Fi unit etc. Features two selectable operating mode: wireless headphones for personal audio and scans for your favourite FM radio programmes.

NEW

- Built-in rechargeable Li-ion batteries
- Transmitter also acts as a charging base for the headphones
- Transmission range: 15m

AA-2071

Also available: **NEW** 2.4GHz Digital Wireless Headphones with FM Radio **AA-2073** $99.00

$79.95

DIGITAL TV SIGNAL STRENGTH METER

Take out the stress from installing your digital TV antenna by using this DVB-T signal strength meter. Connect the pocket sized DVB-T signal strength meter and adjust the angle of your digital TV antenna, the easy to read LED indicator lets you know when you've hit the right spot. Adapters included.

$39.95

NEW

- Requires 1 x 9V battery

LT-3332

MICRO USB TO HDMI MHL ADAPTOR

This MHL (Mobile High-Definition Link) Adaptor connects your MHL enabled Phone (eg. Galaxy SII) or Tablet to your HDTV for viewing content on a larger screen. Great for playing your movies or photo slide shows on your Smartphone or Tablet on a large TV.

NEW

$39.95

- Includes Micro USB cable to power the adaptor and charge your device
- Supports video resolution up to 1280x720p

WQ-7421

INDOOR TV AMPLIFIER SPLITTER

This unit is an analogue and digital television splitter/amplifier for use in multiple receiver applications. Operates from 240VAC and is mounted in a white ABS housing with integral mounting lugs.

- F type input/output connectors
- Frequency range 40 - 860 MHz
- Size: 60(W) x 40(H) x 85(L)mm

LT-3287 WAS $99.00

$89.00
SAVE $10.00

SATELLITE FINDER WITH LED DISPLAY

Align a satellite dish quickly and accurately with this handheld satellite finder. Connected between the satellite dish and set top box the meter displays signal strength on the 6 LED display. Perfect for setting up permanent dishes as well as portable systems on caravans or RVs.

$24.95

NEW

- Size: 90(L) x 48(W) x 31(H)mm

LS-3302

5.8GHZ WIRELESS AV SENDER

Easily share audio and video signals from your cable TV or Blu-ray player with this wireless device. The powerful 5.8GHz transmitter and receiver provide excellent picture and audio quality so you can enjoy your movies or TV shows anywhere in the house without interruption.

$129.00

- Supports either PAL or NTSC
- Size: 105(W) x 150(D) x 38(H)mm

AR-1840

Additional receiver available - **AR-1841** $79.00

DIGITAL INDOOR/OUTDOOR ANTENNA

Enjoy crystal clear TV reception with this digital indoor and outdoor antenna. Its contemporary space saving design enables it to be mounted on a wall - great for apartments and those with minimal space. AC adaptor included.

- Frequency: VHF - 174-230MHz, UHF - 470-862MHz
- Antenna gain: 10dB
- Total gain: 40dB
- Size: 502(L) x 235(W) x 76(H)mm

LT-3137 WAS $99.00

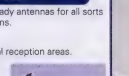
$79.00
SAVE $20.00

UHF TV ANTENNAS

See our range of digital ready antennas for all sorts of locations and applications.

43 Element

Suitable for medium signal reception areas.



- Elements - 43
- Gain - 13dB
- Channels - 21 to 69
- Bands - 4 & 5
- Boom Width - 20mm sq
- Overall Length - 1234mm

LT-3181 $44.95

91 Element

Huge antenna suitable for deep fringe signal reception.

From **$44.95**

- Elements - 91
- Gain - 15 - 19dB
- Channels - 21 to 69
- Bands - 4 & 5
- Boom Width - 20mm sq
- Overall Length 2214mm

LT-3182 $89.95

YOUR LOCAL JAYCAR STORE - Free Call Orders: 1800 022 888

• AUSTRALIAN CAPITAL TERRITORY

Belconnen	Ph: (02) 6253 5700
Fyshwick	Ph: (02) 6239 1801

• NEW SOUTH WALES

Albury	Ph: (02) 6021 6788
Alexandria	Ph: (02) 9699 4699
Bankstown	Ph: (02) 9709 2822
Blacktown	Ph: (02) 9678 9669
Bondi Junction	Ph: (02) 9369 3899
Brookvale	Ph: (02) 9905 4130
Campbelltown	Ph: (02) 4620 7155
Castle Hill	Ph: (02) 9634 4470
Coffs Harbour	Ph: (02) 6651 5238
Croydon	Ph: (02) 9799 0402
Erina	Ph: (02) 4365 3433
Gore Hill	Ph: (02) 9439 4799
Hornsby	Ph: (02) 9476 6221
Liverpool	Ph: (02) 9821 3100
Maitland	Ph: (02) 4934 4911
Newcastle	Ph: (02) 4965 3799
Penrith	Ph: (02) 4721 8337
Port Macquarie	Ph: (02) 6581 4476
Rydalmere	Ph: (02) 8832 3120
Sydney City	Ph: (02) 9267 1614
Taren Point	Ph: (02) 9531 7033
Tweed Heads	Ph: (07) 5524 6966
Wagga Wagga	Ph: (02) 6931 9333
Wollongong	Ph: (02) 4226 7089

• NORTHERN TERRITORY

Darwin	Ph: (08) 8948 4043

• QUEENSLAND

Aspley	Ph: (07) 3863 0099
Caboolture	Ph: (07) 5432 3152
Cairns	Ph: (07) 4041 6747
Capalaba	Ph: (07) 3245 2014
Ipswich	Ph: (07) 3282 5800
Labrador	Ph: (07) 5537 4295
Mackay	Ph: (07) 4953 0611
Maroochydore	Ph: (07) 5479 3511
Mermaid Beach	Ph: (07) 5526 6722
Nth Rockhampton	Ph: (07) 4926 4155
Townsville	Ph: (07) 4772 5022
Underwood	Ph: (07) 3841 4888
Woolloongabba	Ph: (07) 3393 0777

• SOUTH AUSTRALIA

Adelaide	Ph: (08) 8231 7355
Clovelly Park	Ph: (08) 8276 6901
Gepps Cross	Ph: (08) 8262 3200
Reynella	Ph: (08) 8387 3847

• TASMANIA

Hobart	Ph: (03) 6272 9955
Launceston	Ph: (03) 6334 2777

• VICTORIA

Cheltenham	Ph: (03) 9585 5011
Coburg	Ph: (03) 9384 1811
Frankston	Ph: (03) 9781 4100
Geelong	Ph: (03) 5221 5800
Hallam	Ph: (03) 9796 4577
Kew East	Ph: (03) 9859 6188
Melbourne	Ph: (03) 9663 2030
Ringwood	Ph: (03) 9870 9053
Shepparton	Ph: (03) 5822 4037
Springvale	Ph: (03) 9547 1022
Sunshine	Ph: (03) 9310 8066
Thomastown	Ph: (03) 9465 3333
Werribee	Ph: (03) 9741 8851

• WESTERN AUSTRALIA

Joondalup	Ph: (08) 9301 0916
Maddington	Ph: (08) 9493 4300
Midland	Ph: (08) 9250 8200
Northbridge	Ph: (08) 9328 8252
Rockingham	Ph: (08) 9592 8000

Arrival dates of new products in this flyer were confirmed at the time of print. Occasionally these dates change unexpectedly. Please ring your local store to check stock details. **Prices valid from 26th December to 23rd January 2012.** All savings are based on original RRP

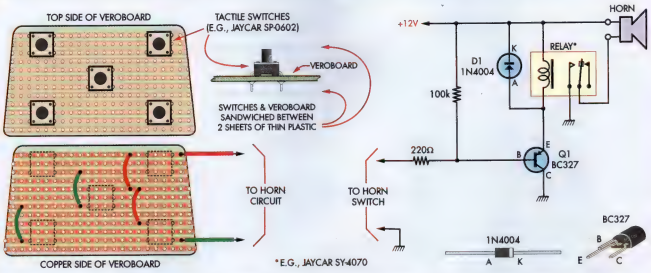
Head Office
320 Victoria Road, Rydalmere NSW 2116
Ph: (02) 8832 3100 Fax: (02) 8832 3169

Online Orders
Website: www.jaycar.com.au
Email: techstore@jaycar.com.au

Jaycar electronics
Better. More Technical

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions will be paid for at standard rates. All submissions should include full name, address & phone number.



Replacement horn circuit for a car

This circuit was devised to replace the horn contacts that were damaged after removing the steering wheel on a Mitsubishi Express van. It can be adapted to other models and the horn relay circuit could also be employed if there is a need to install extra horns in a vehicle.

Five tactile switches are installed on a section of Veroboard which is cut to shape to fit under the horn button. The tactile switches are wired to alternate tracks of the Veroboard and are all effectively connected in parallel so that as long as one of the switches is closed, the relay will be energised and the horn will sound.

The Veroboard and switch assembly is sandwiched between two sheets of thin plastic which can be sourced from the lids of take-away food containers.

Geoff Coppa,
Toormina, NSW. ($40)

Program variation for Digital Spirit Level

Back in October 2011, we published a program variation for the Digital Spirit Level (August 2011) which allowed it to read gradients as a percentage rather than in degrees. That was useful but readers commented that the auto switch-off is a nuisance in some applications. What was wanted was a variant like the G-Force meter (November 2011) which has a normal power switch.

Accordingly, a new version of the code has been created which eliminates the auto switch-off facility. It still reads degrees or percentage, as selected by pressing the calibrate switch for about five seconds and then the display will toggle between the two modes. A short press on the calibrate button will zero the reading, as in previous versions.

The calibration reading and the selected mode are stored in non-volatile memory so you do not need to select the mode each time you use the device. Hence, in the degree mode, the instrument reads from 0° to 360° in 0.1° increments. In percentage mode, it shows 0.0% to 99.9% gradient between 0° and 45° and between 180° and 215°.

Conversely, it displays 0.0% to -99.9% between 315° and 360° and between 135° and 180°.

The software, Digital Inclinometer Always On.zip, can be downloaded from the SILICON CHIP website.

Andrew Levido,
Wollstonecraft, NSW. ($70)

Contribute And You Could Win An LCR Meter

We pay for each of the "Circuit Notebook" items published in SILICON CHIP but there is another reason to send in your circuit idea.

Each month, at the discretion of the editor, the best contribution published will entitle the author to a nifty, compact LCR40 LCR meter, with the compliments of Peak Electronic Design Ltd – see **www.peakelec.uk**

So send that brilliant circuit idea in to SILICON CHIP and you could be a winner.

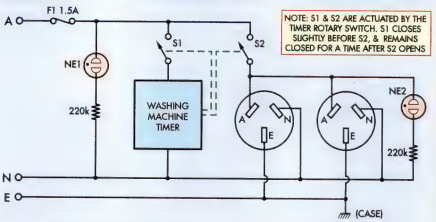
You can either email your idea to silicon@siliconchip.com.au or post it to PO Box 139, Collaroy, NSW 2097.

Recycling a clothes dryer timer

For those people who want a mains timer but were not attracted by the PICAXE circuit published in the Circuit Notebook pages of the October 2011 issue, this much simpler approach using a timer recycled from a clothes dryer may have more appeal.

These timers are based on a small AC motor (usually a synchronous type), geared down to rotate a shaft (and knob) at a very low rate. In the fully anti-clockwise (OFF) position, the shaft opens two 250VAC mains-rated switches. One of these feeds power to the timer motor on which it is mounted and the other feeds the dryer motor.

The switch that trips the dryer motor opens slightly before the switch that removes power from the timer motor. Turning the knob clockwise energises the timer motor and the load and how far you rotate it from the off position determines how long before it turns off.



The prototype was mounted in a suitable box with a mains fuse, a pair of mains neon lamps, a couple of 250VAC 3-pin outlets and a 3-core power lead. One neon indicator is connected across the mains input and the other across the output sockets.

Brian Critchley,
Elanora Heights, NSW. ($40)

Solar tracker employs two photo cells

This circuit is based on a PIC16F88 microcontroller (IC1), which performs all the necessary control functions so that a solar panel can track the Sun as it moves across the sky.

IC1 is fed with input signals from a pair of low-power photo-sensors which, in the case of the prototype, are miniature photovoltaic panels, similar to the kind typically used in solar-powered calculators. These signals should not exceed 3V and are current-limited by the 2.2kΩ input resistors.

The photo-sensors should be mounted to move with the solar panel so as to point in the same direction as the panel. In addition, a shadow plate should be placed between the photo-sensors, with one sensor placed close to the eastern side of the shadow plate and the other placed close to the western side, such that when the panel is directly facing towards the Sun, the shadow falls between the sensors.

The height of the shadow plate should be 10 times or more the width of the sensors. Trimpot VR2 should be adjusted so that the signal voltages are equal when the full Sun shines equally on both sensors.

The solar panel is driven by a motor and gearbox assembly and a range of motors can be employed since the motor DC supply can be anywhere from 8-30V. The motor is controlled by a pair of P-channel Mosfets, Q1 & Q2, together with a pair of N-channel Mosfets, Q3 & Q4.

Q1 & Q2 are driven by NPN transistors Q5 & Q6 while Mosfets Q3 & Q4 are controlled via a UCC27424 Mosfet driver, IC2. The four Mosfets are connected in an H-bridge configuration with the upper pair used to control the direction of the motor while the lower pair control the speed.

IC2 ensures minimum switching losses in the lower Mosfets, which are pulse-width modulated (PWM). A dedicated driver is not required for the upper Mosfets because these are not pulse-width modulated.

As the Sun moves towards the west, the shadow cast by the shadow plate moves over the photo-sensor on the eastern side. IC1 responds by running the motor until the shadow once again falls between the sensors.

The acceleration and speed of the motor are controlled in the programming to ensure a smooth tracking response. After sunset the motor will automatically return the panel towards the east, in readiness to catch the Sun the following morning.

Herman Nacinovich is this month's winner of a Peak Atlas Test Instrument

The motor will not track under cloudy or overcast conditions because it may become erratic due to the resulting low light contrast or due to reflections from clouds. A pair of limit switches (S1 & S2) should be arranged for sensing when the solar panels are facing approximately due east or approximately due west, respectively.

Programmed limits

IC1 is programmed to stop the motor if the latter attempts to move the panel beyond the preset limits set by the switches. This prevents possible damage should something go wrong and the motor otherwise fails to stop.

The motor's current drain is monitored via the 0.1Ω 5W wirewound resistor common to the sources of Mosfets Q3 & Q4. If the motor current rises to excessive levels due to

jamming or running to the limits of the gearbox, the microcontroller reduces the pulse width of the gate drive signals.

IC1's programming allows the motor to be controlled in a manual mode, as well as a tracking mode. Manual mode is selected by closing switch S3; tracking mode is selected by opening the switch.

Manual mode can be handy for setting up and testing. In this mode, the motor is controlled by means of potentiometer VR1. The motor stops when VR1 is set to centre position. Moving VR1 progressively towards 5V from centre position causes the motor to move correspondingly faster in the forward direction.

Conversely, moving VR1 progressively towards 0V from centre position causes the motor to move correspondingly faster in the reverse direction. A fairly wide "neutral zone" around centre position, which is set in the programming, minimises the risk that the motor will start should the potentiometer be bumped. The motor will stop in manual mode, as well as in tracking mode, if it attempts to move the panels beyond the limits set by the limit switches.

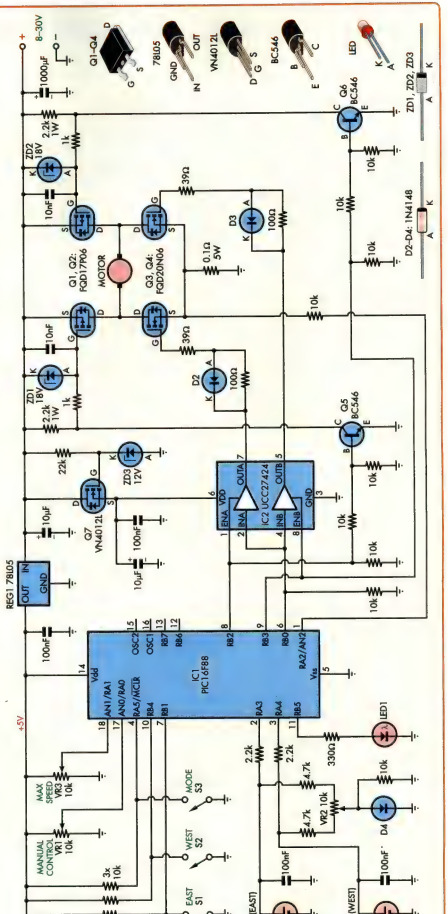
Motor duty cycle

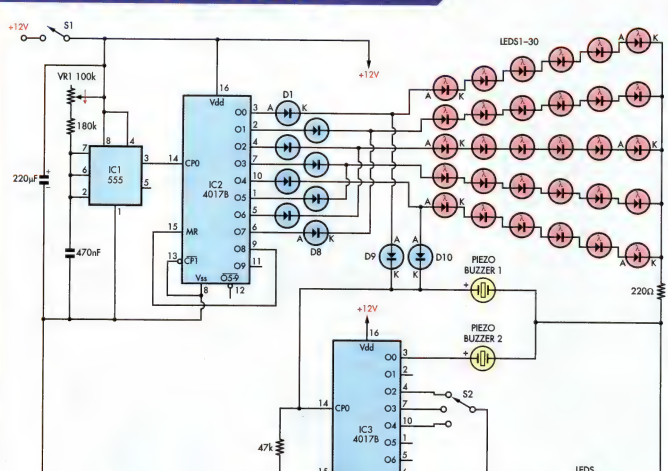
The maximum motor duty cycle (in either mode) is set by potentiometer VR3. There are two reasons for this provision. First, maximum motor power may not be required and so limiting the motor duty cycle may help to reduce unnecessary stress on the motor and other parts, particularly in the case of a mechanical failure. Second, if the power source is 24V, for example, and if the motor is rated for 12V, then limiting the duty cycle becomes mandatory to prevent motor damage. In the case of the prototype, a 12V motor was used and this ran quite happily with the controller connected to a 24V power source.

The default operating parameters, such as maximum duty cycle, motor current limit, etc have been optimised for the prototype and should be suitable for most situations. However the parameters can easily be modified in the source code, if necessary, to suit different requirements.

The software, SolarTrak Source Codes.zip, can be downloaded from the SILICON CHIP website.

Herman Nacinovich, Gulgong, NSW.





Audio-visual metronome

This circuit is essentially the digital equivalent of a regular metronome. It has an adjustable beat frequency and the beat is indicated both audibly (with a beep) and visually. Every second, third for fourth beat is audibly accented, to indicate the start of each bar.

555 timer IC1 provides the adjustable beat period and its timing is controlled by potentiometer VR1. It forms a simple astable oscillator, where VR1 and the 180kΩ resistor control the rate at which the 470nF capacitor is charged.

When pin 6 reaches about 8V, pin 3 goes low and the 470nF capacitor is discharged via pin 7. When pin 6 subsequently reaches 4V, the pin 3 output goes high again and the process repeats.

The generated square-wave drives the clock input (CP0, pin 14) of IC2, a 4017 decade counter/divider. The first eight outputs of IC2 drive five strings of red LEDs (LEDs1-30) via diodes D1-D8. These LEDs are arranged so that as successive outputs go high (with each pulse from IC1), the LEDs light in a 1-2-3-4-5-4-3-2 pattern, simulating a swinging pendulum.

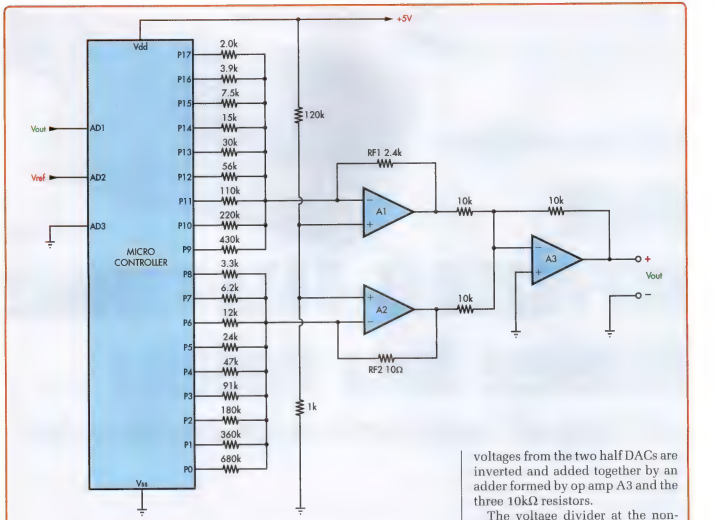
This sequence repeats indefinitely as IC2's ninth output is connected to its master reset (MR, pin 15) input.

When the first and last LED strings light, IC2 also drives piezo buzzer 1 via diode D9 or D10, so the beat sounds as the "pendulum" reaches the limits of its "swing". At the same time, a clock pulse is delivered to IC3, a second 4017 decade counter. Rotary switch S2 selects between two, three and four beats per bar.

At the start of each bar, IC3 drives piezo buzzer 2 to accent the beat (they should ideally be different types). Switch S2 determines how many clock pulses IC3 requires before it is reset (via its MR input, pin 15) and therefore how often the accented beat sounds.

The circuit runs from a regulated 12V supply and can be turned on and off by power switch S1.

A. J. Lowe,
Bardon, Qld. ($50)



Wide current-mode 18-bit DAC

Current-mode DACs have the useful property that each bit-weighting resistor independently determines the voltage contributed by that bit to the total output voltage. This makes possible DAC schemes that measure the individual voltage contribution of each bit and calculate the appropriate digital value to present to the DAC to obtain a desired output voltage.

A downside of current-mode DACs is that their current requirements double with each added bit of width. A wide current-mode DAC will therefore suffer by either having such a low current in the lowest-order bit-weighting resistor that it will be swamped by noise, or the highest-order bit-weighting resistor will have such a high current in it that it will heat up, affecting its value (not to mention that the total current drain of the DAC may also be prohibitive).

The circuit shows a solution to this problem using an 18-bit DAC with non-precision weighting resistors as an example. The solution is to split the 18-bit DAC into two 9-bit DACs, each with its own I-V (current-to-voltage) converter. A 9-bit DAC is not so wide that it suffers from the above problems: if the current contributed by the bit 0 weighting resistor is around 10µA the current in the bit 8 weighting resistor will be around 2.5mA.

The I-V converter for the upper nine bits is formed around op amp A1 and has a 2.4kΩ feedback resistor, while the I-V converter for the lower nine bits is formed around op amp A2 and has a 10-ohm feedback resistor. The result is that while the currents in the two half DACs are roughly similar, the output step voltage of the upper half DAC is about 240 times that of the lower one. The voltages from the two half DACs are inverted and added together by an adder formed by op amp A3 and the three 10kΩ resistors.

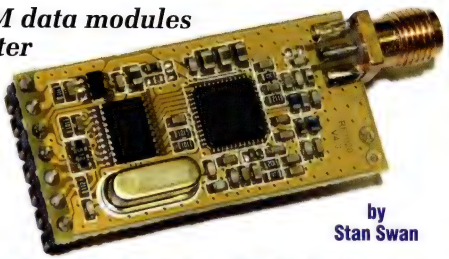
The voltage divider at the non-inverting inputs of A1 and A2 holds those inputs at 41mV. This is intended to be slightly more than the sum of the maximum input offset voltages of A1, A2 and A3. This guarantees that Vout will be slightly negative when the digital input is 0 and enables the output range to include 0V to within half the output step voltage of the DAC.

The resulting DAC has an output range of 0-12.16V with a maximum output step voltage of 76.3µV. As far as the microcontroller is concerned the two DAC halves behave as a single DAC with the appropriate bit weights.

The microcontroller can calibrate the DAC by turning on each output in turn and measuring the output step with reference to Vref. For best accuracy, use a micro with a high-resolution internal analog-to-digital converter (ADC) or with an internal programmable-gain amplifier (PGA).

Andrew Partrige,
Toowoomba East, Qld. ($65)

Chinese 434MHz ISM data modules just keep getting better and better!



First Impressions:

Dorji DRF7020D13-043A 433MHz Wireless Data Modules . . .

And then we make some simple data repeaters

by Stan Swan

Although restricted to just a few tens of milliwatts transmit power, the licence-free 433.92MHz ("433") ISM (Industrial, Scientific and Medical) UHF band has continuing appeal for both professionals and hobbyists.

Originally reserved for non-commercial radio use, considerable innovative data handling has emerged in recent times, with the low data rates (~9600bps) especially tempting for easy microcontroller wireless applications.

Of course, 2.4GHz Bluetooth, WiFi and ZigBee wireless gear now abounds but these technologies best suit only very close links, as the higher radio frequencies are blocked by almost anything in the way.

In crowded Asian cities, low-data-speed 433MHz devices are preferred for utility reading, as lower UHF frequencies have better "punch" through obstructions.

Although surprising performers for what they are, most cheap 433MHz data modules are generally *very* low powered (a mere few milliwatts) and often the receiver is somewhat "deaf".

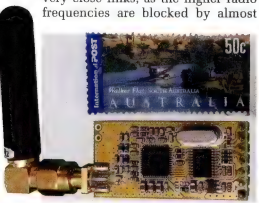
Jaycar's venerable ZW3100 and ZW3102 ASK (Amplitude Shift Keying) AM pair are typical, with their continued popularity relating to ease of use and simple set-ups.

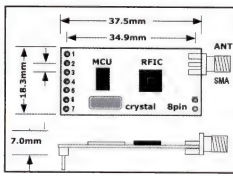
Superior FSK (Frequency Shift Keying) FM types are usually less susceptible to interference, although bandwidth will be greater. Enhanced performance however comes with GFSK (Gaussian Frequency Shift Keying) modulation, as the outgoing data is shaped to a narrow bandwidth, thereby improving receiver sensitivity.

Dorji DRF7020D13

Australian PICAXE agents Microzed now handle a range of Chinese-made Dorji 433MHz GFSK modules and adapters. There's even an innovative DRF5150S wireless sensor transmitter (and matching DRF4432S receiver) that can directly read such industry standard sensors as the Maxim DS18B20. That's right – no external micro needed!

Module prices are around $25 each.





The module really is small, as shown here (with a stamp for comparison!). Below is the connection data.

PIN	Name	Function	Description
1	GND	Ground	(0V)
2	Vcc	Power	3.4-5.5V DC supply
3	EN	Input	Enable pin (>1.6V)
4	RXD	Input	UART input, TTL level
5	TXD	Output	UART output, TTL level
6	AUX	Output	Data In/Out indication
7	SET	Input	Parameter setting pin

Several Dorji transmitters however have powers that exceed the 10dBm (10mW) or 13dBm (25mW) 433MHz limit legally permitted in most Western countries.

The stamp-sized (OK, large stamp!) DRF7020D13-043A transceiver appeals for its features and legal transmitter and it's this that the article focuses on.

The "7020D13" (so called for its RF IC) is powerful (20mW), sensitive (around -118dBi at low data rates), versatile and easy to use.

Inbuilt buffers and error correction give reliable "wireless serial port" action – essentially what's sent out at the TX (transmitter) of one module is transparently seen at the RX (receiver) of the other. The modules handle all the hard work!

A rugged gold plated SMA antenna socket is also featured, so you can connect the antenna of your choice. More on this shortly.

They are indeed a little power house!

Leading-edge 433MHz offerings of just a few years back, although considered smart at the time, increasingly look quite tame in comparison.

Dorji modules – the name arises from a Tibetan word meaning "a reliable and trustworthy guardian of peace and justice" – are noticeably similar to other Chinese models.

Close inspection reveals a common use of the high-performance Analog Devices ADF-7020-BCPZ transceiver IC (**www.analog.com/en/rfif-components/rfif-transceivers/adf7020-1/products/product.html**), although a "1BCPZ" was noted on the Dorji.

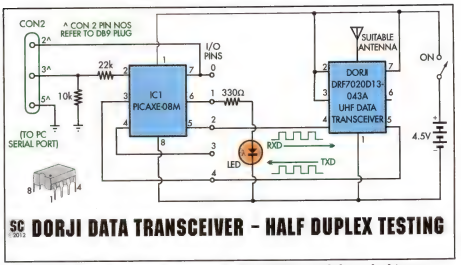
Controlling micros may also differ; for example Atmel on one versus "0C002" on the Dorji.

As they have a different on-board microcontroller and RF IC hardware, the likes of Appcon's "RF Magic" configuration software probably won't work with the Dorji transceivers.

PICAXE coding

Pleasingly, the Dorji 7020 modules work "out of the box" on 433.92MHz and at their full 20mW transmit power. This may be all many users need – however, configuring to your own needs, perhaps if local interference arises, can readily be done – see later details.

The modules' 0.1-inch SIP connections suit breadboard experimentation



The circuit is very similar to earlier PICAXE 433MHz modules – the biggest difference is that we haven't had a moment's difficulty getting the Dorji to work!

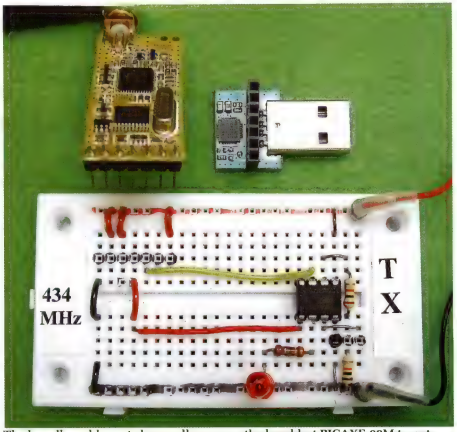
and almost trivial PICAXE-08M test coding can put them through their paces.

The infamous PICAXE serial in hang up was got round here by using PULSIN, as this command does "move on" if no data is received!

Of course, no sooner had this approach been organised than our Postman Pat delivered some of the new fire-breathing 08M2s, which thankfully now respond to SERIN timeouts and could be used instead – call it "Dorji's Law" maybe ?

But we believe most constructors will still be using 08M's so the PULSIN approach has been initially retained.

Note: The 08M2 now requires its pins to be known as C.0, C.1, C.2, C.3, C.4, C.5, whereas the 08M simply used the pin number without the "C." in front. The latest PICAXE programming



The breadboard layout shown allows even the humblest PICAXE-08M to put the Dorji 433MHz module to work. The small USB-TTL adaptor (top right) conveniently allows configuration setting using Dorji's "DRF Tools" software.

```
'DORJI DRF7020D13-433MHz TX/RX trial set up Stan SWAN Jul2011
'Makes use of the slight reading "wait" of PULSIN to prevent 08M serial hangup!

dorji:
serout 2,t1200,(b0)     ' PING. b0 just a handy "placeholder"- can be anything
pulsin 4,0,b1           ' listens pin 4 - reads & briefly awaits any reply
if b1=0 then dorji      ' if nothing heard then "ping" again & await reply

serin 4,t1200,b0        ' routine when a response heard after pinging
pulsout 1,200           ' LED flash indicating data received
goto dorji
```

Simple trial "ping-pong" driving code to check that each module is in contact with its partner. This code suits the popular PICAXE 08M but can also be used with the newer (and more powerful) 08M2.

editor automatically converts pins to the new b.# style and 08M2 users can further retain 08M compatibility by adding "let dirsb = $FF" as an initial code line.

In the panel above is a simple trial "ping-pong" driving code – note the "t" before the baud rate. These modules use a non-inverted "true" data mode ("t") rather than inverted ("n"). True uses a high idle state, with low start and high stop communications bits surrounding the "10101010" style eight data bits.

The resulting action is akin to a "Hello 1 this is 2 can you hear me? Over" style radio check, with a "Hello 2 this is 1. I heard you – please confirm that you've received my report back to you" response.

Voice radio operators naturally would soon go crazy continually ping-ponging mindless signal reports like this, even though it verifies each end IS actively sending and receiving. At a data level, however, it conveniently allows one-man testing of the modules' range – when the local LED stops winking, the far end is no longer linked. Enlisting a non-technical buddy to help with such coverage tests may otherwise soon become an exercise in boredom for them!

The aux output on Pin 6 (and supposedly indicating TX / RX activity) remains at a constant low on transmit but it briefly goes high on receive, for a period related to the length of the data packet.

Simple tests confirm this is long enough to blip a LED and/or trigger a PICAXE interrupt.

The DRF7020D13 module has no RSSI (received signal strength) or WOR/W (wake on radio/wireless) tap points to awaken a snoozing system if signals arrive. However PICAXE driven "SLEEP" control of Dorji pin 3 (EN) control can greatly help, although a scheme is then needed to match to the signal transmission rate.

Field testing

Quick trials with a matching pair of DRF7020D13 modules, organised to run half duplex with control by PICAXE-08Ms, readily managed 300m range through typical NZ light timber frame buildings plus assorted sheds and vegetation.

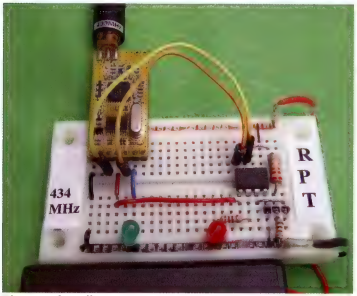
Both setups were identically coded and wired, with Dorji pins 2(Vcc), 3(EN) and 7(SET) run to the positive supply – refer layout. (These 3 links are wired under the module and thus obscured on the picture).

Even when placed right beside each other the units worked fine, with no sign of overloading.

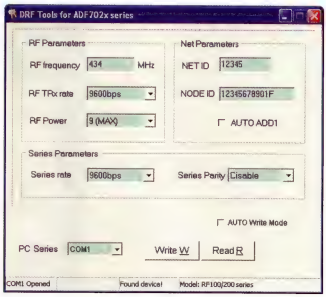
The supply needs range from 3.4-5.5V, conveniently suiting three "AA" cells (~4.5V). Active current drains were about 30mA but could be lowered with PICAXE 'SLEEP' commands.

Several supplied antennas were used, with even the stubby one (~45mm long) performing well. Although deceptively short, it's indeed labelled 433MHz!

Past experiences indicate several



The same breadboard layout, with only minor variations,suits all our Dorji trials. The extra LED at pin 6 (AUX) shows receiver traffic, while jumpers from Dorji pins 5 (TXD) and 3 (EN) running to PICAXE pins 3 (data in) and 4 (sleep/wake) permit enhanced repeater control (mentioned later).



Although parameters can be set from the driving microcontroller, module configuration is most readily done via a small USB-TTL adaptor using Dorji's "DRF Tools" software.

kilometres line of sight (LOS) should be possible with the longer antenna.

To put such performance in some sort of perspective, even at the default "9" (=13dBm or a mere 20mW) the TX power is only about that of a LED. In daylight a LED would be hard to see at 10m!

Antenna

The module's gold-plated SMA socket suits the various stubbies but this means you could also connect your own antenna. Aside from such classic options as a quarter-wave whip (~170mm long at 433MHz), Yagi or Slim JIM, the best range boosts at UHF come by elevating the receiver and transmitter.

Tests once made with 470MHz UHF CB sets, progressively elevating outdoors from ground-level to rooftop, showed ranges were boosted nearly an order of magnitude this way.

For demanding links, mount the 433MHz modules as high as possible (perhaps within a plastic container) and run the low-speed data and DC supply up to them from below.

Note that power boosting is usually illegal – Australian/NZ 433.92MHz LIPD ISM regulations (revised Jan. 2009) say the transmitter should not exceed 25mW EIRP (Equivalent Isotropically Radiated Power).

Some countries limit the transmitter power to only 10mW and allow a gain antenna only at the receiver. A possible alternative could be to organise a simple data repeater – see later ideas.

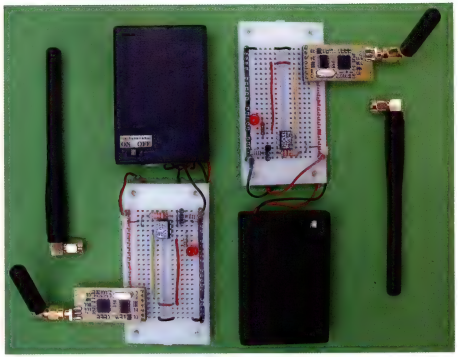
Setup configuration:

As with similar USB/serial configurations, getting serial adaptor modules talking to a USB-fitted PC may be "trial by driver and hardware".

However the Dorji USB-TTL adaptor (detected as a SiLabs "CP2102 USB to UART bridge controller) worked seamlessly once its drivers were sourced (via www.dorji.com/info/download.html). As this adaptor is only about $12 it will probably become the hardware configuration standard.

The 433MHz ISM band covers a 1.7MHz spectrum slice from 433.05 to 434.79MHz, so quiet slots and multiple channels, well removed from the usual 433.92MHz "RF soup", may be utilised.

Tweaking power settings and data rates (both "on air" and serial) can also give worthwhile performance



Range testing can be conducted using two identically wired, configured and programmed breadboard setups. Several SMA fitted antenna are available – even the shortest ones were found to be good performers.

boosts and/or battery life extensions. The PICAXE-Dorji interface rate can go as low as 1200 bps but 2400 bps will probably be most suitable.

This UART (Universal Asynchronous Receiver Transmitter) rate is slower than the modules' usual "on air" 9600 bps but slower RF transmission rates often perform better, as signals occupy narrower bandwidth.

Hence try also setting the "RF TRx rate" to 2400 bps.

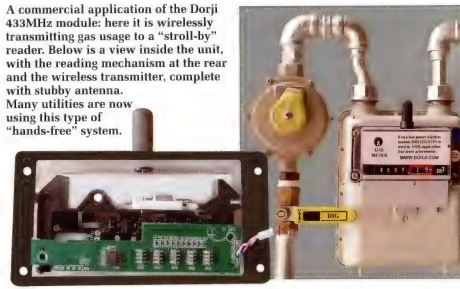
NB: Net and Node ID configuration parameters seem meaningless in the "DRF Tools" utility. Providing the frequency and data rates match, the modules communicate no matter what these are set to! These two options are apparently intended to suit mesh networking but such capabilities remain under development and are presently disabled.

Of course, a simple network can still be created with a protocol provided with PICAXE serin "ABC" style qualifiers for station ID and data handling.

Transceiver configuration is also possible directly (at 9600 bps) via the driving microcontroller – the setup mode is entered simply by setting the Dorji module SET pin (7) to low.

Configuration syntax follows the

A commercial application of the Dorji 433MHz module: here it is wirelessly transmitting gas usage to a "stroll-by" reader. Below is a view inside the unit, with the reading mechanism at the rear and the wireless transmitter, complete with stubby antenna. Many utilities are now using this type of "hands-free" system.



DRF 7020 D 13 - 043 A

❶ ❷ ❸ ❹ ❺ ❻

❶ RF module	RF GFSK Module
❷ IC Type	ADF7020
❸ Module Function	Data Transmission
❹ Power	13dBm output power
❺ Frequency Band	043: 433MHz
❻ Package	DIP package with SMA connector

Parameter	Unit	Length (Bytes)	Explanation
Frequency	kHz	6	433.92MHz = 433920 (Covers 418-455MHz)
DR_{FSK}	Kbps	1	1 = 2400bps, 2 = 4800, 3 = 9600, 4 = 19200
P_{OUT}	dB	1	0-9 (0 = -1dBm; 9 = 13dBm)
DR_{IN}	Kbps	1	0 = 1.2, 1 = 2.4, 2 = 4.8, 3 = 9.6, 4 = 19.2, 5 = 38.4, 6 = 57.6
Parity		1	0 = no parity, 1 = even parity, 2 = odd parity

(Left): here's how to identify the Dorji module's specifications from its type number. (Right): the user parameters you can set when you know the code!

write command style

WR_Freq_DRFSK_POUT_DRIN_Parity

Therefore to set the module to work at Freq (433.92MHz), DRFSK (9.6k bps), POUT (13dBm), DRIN (1.2K bps) and Parity (no parity), enter the 10-byte command

WR_433920_3_9_0_0

The module will promptly respond back this string to confirm parameter acceptance. Once SET is adjusted back to high the new settings can be utilized.

Simple repeater

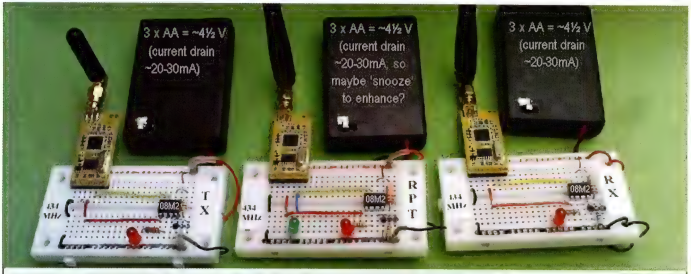
As a simple circuit extension, a proof-of-concept 433MHz and PICAXE-08M2-based simplex "store and forward" data repeater ("digi-peater") was organised.

Decades of amateur radio 144MHz voice repeater experience had given familiarity with probable benefits and this quest was largely intended as a check on DORJI based data repeater potential.

A typical use may arise with wireless temperature monitoring deep inside a building, with the weak acquired data signal then rebroadcast by a rooftop repeater to a more distant receiver.

The set up below gave ~100m range in such circumstances but pleasingly >1km via an elevated repeater!

Data is sent transparently under EDAC (Error Detection and Coding), via an inbuilt 256-byte buffer that kicks in if the 'on air' rate is less than the



Transmitter

```
'Dorji 'DRF7020D13 433MHz transceiver - TX
'Data must be "t" to work – "n" gives corruption
'Use with companion rxdorji & maybe repeater?
dorji:
for b0=1 to 100          'Counts 0-100 = easy check!
serout 2,i1200,("ABC",b0)
pulsout 1,200
pause 1000
next b0
goto dorji
```

Repeater

```
'Dorji 433MHz simplex data REPEATER
rptdorji:
serin [2000,lost],4,i1200,("ABC"),b0
serout 2,i1200,("ABC",b0)
goto rptdorji
lost:
pulsout 1,100            'uplink lost - LED alert
goto rptdorji
```

Receiver

```
'Dorji 433 receiver - use with companion txdorji RX
'Exploits new PICAXE 08M2 serin timeout features
rxdorji:
serin[2000, lost],4,i1200,("ABC"),b0
sertxd (#b0,CR,LF)       'NB - 'doubled' data display
pulsout 1,200            'is shown if both TX &
goto rxdorji             'repeater are in range!
lost:
sertxd ("Data link lost...")
goto rxdorji
```

Although programmed differently, all three modules are laid out essentially the same, except for an extra (green) LED on the repeater's pin 6 to show uplink data received. If both the transmitter and repeater data is received then a distinctive doubled data display shows – very handy for field trials (by noting receiver LED double wink). Set all three modules initially (via the Dorji USB adaptor?) to 433.000MHz, with 9600 bps on air and 1200 bps data rate.

UART data rate.

The test circuitry was still based around the earlier layout for all three modules (transmitter, repeater and receiver), although the PICAXE microcontroller on each required individual programming; a near trivial task thanks to Rev. Ed's user-friendly editor.

The new PICAXE-08M2 'serin' timeout and redirect options were used to redirect the program sequence if the uplink transmission was lost for more than 2000ms (2s).

Past PICAXE serial "hang-ups" (often requiring cussed code workarounds) are thus now thankfully avoided.

Elevating this repeater above obstacles worked wonders for improving coverage in difficult UHF environments (trees/buildings/terrain), showing impressive LOS range boosts.

From a favourable hillside site repeater coverage even extended some 8km across Wellington Harbour.

Such a very basic data repeater can be greatly enhanced and tweaked, of course. At the very least the repeater (which could be hauled up a tree/sited on an elevated pole/rooftop and powered by battery or even solar PV panels) can employ some current reducing snoozing 'down time'.

It's presently drawing a rather high 30mA and if powered by three AA cells, the drain could flatten them in less than a week.

Although a solar panel (around 2-5W) and rechargeable cells could ease this drain, battery replacement may soon become irksome and costly.

Enhanced repeater

When monitoring the likes of (say) ambient temperature or water levels, the very nature of such slowly changing values may justify only occasional data sending.

As time-critical data would probably go via cellular phone now anyway, it's wasteful to leave the repeater fully-powered for infrequent signals, especially since PICAXE controlled snoozing can be easily employed.

Naturally consideration of the overall system, particularly the consequences of missing/awaiting key data signals, may dictate approaches.

A simple technique just involves the repeater awakening (via a PICAXE sourced "high" to the Dorji's 'EN' pin 3) every minute for a few seconds and then listening for the data being

Here's some initial transmitter uplink code, which simply repeatedly counts to 100 – the appeal of this relates to easy spotting of any lost values at the receiver terminal screen

```
Dorji DRF7020D13-433MHz simplex "store & forward" data TX uplink
' PICAXE-08M2 - use with suitable repeater & RX downlink code
' Refer code hosted at => www.picaxe.orcon.net.nz/dorji-rpt-tx.bas
' EXTEND TO SUIT ! via => stan.swan@gmail.com Oct. 2011
dorjitx:
b2=4                                    ' trial sleep value (~ 10 seconds)
for b0=1 to 100                         ' simple counting routine
serout 2,t1200,("ABC",b0,b2)            ' data sent out from transmitter
wait 1
next b0
goto dorjitx
```

The companion repeater code follows – this makes use of the 08M2's new SERIN timeout feature to await data and even drop to a suitable lost alert if nothing is heard.

```
' Dorji DRF7020D13-433MHz simplex "store & forward" data repeater
' PICAXE-08M2 - use with suitable TX uplink & RX downlink code
' Refer code hosted at => www.picaxe.orcon.net.nz/dorji-enh-rpt.bas
' EXTEND TO SUIT ! via => stan.swan@gmail.com Oct. 2011.
' Enhanced for low drain sleep (<1mA). Note-b2 SLEEP value sent from TX!
' Thus usefully controls remote repeater hibernation- modify to suit!
' Found b2=4 gave ~10 secs, b2=27 =~1 min)-effectively off if b2=255 (~10 mins)
' Still awakens (eventually!) to monitor TX uplink & action (shortened?) b2 value.
' b0=actual data (here numbers 0-100), b1=loop control, b2=sleep value
rptdorji:
high 4                                  ' high to Dorji EN (pin3)to awaken
wait 1                                  ' wake up delay
for b1=1 to 2                           ' listening loop for data signal
serin [2000,lost],3,t1200,("ABC"),b0,b2 ' listen for 2 seconds – 'lost' if nothing
serout 2,t1200,("ABC",b0)               ' transmit out received data ( ABC= "qualifier")
next b1                                 ' loop for received data
low 4                                   ' Low to EN (Dorji pin3) for sleep
sleep b2                                ' PICAXE low drain sleep (units ~2.3s)
goto rptdorji                           ' repeat routine
lost:                                   ' optional routine to indicate data uplink lost
pulsout 1,100                           ' uplink lost- LED alert (OPTIONAL)
goto rptdorji                           ' repeat routine
```

The far end receiver code shows values on the program editor's terminal screen, and also utilises the 08M2's enhanced SERIN features to wait a selectable period (here 2000ms) before dropping to a "data lost" alert.

```
' Dorji DRF7020D13-433MHz simplex "store & forward" data RX downlink
' PICAXE-08M2 -use with suitable repeater & TX uplink code
' Refer code hosted at => www.picaxe.orcon.net.nz/dorji-rpt-rx.bas
' EXTEND TO SUIT ! via => stan.swan@gmail.com Oct. 2011

dorjirx:
serin [2000,lost],4,t1200,("ABC"),b0
sertxd (#b0,CR,LF)
goto dorjirx

lost:
sertxd ("Data link lost")
goto dorjirx
```

Links between two setups are typically several hundred metres through timber buildings and light vegetation. This may run to several kilometres in open spaces with good line of sight. This beach trial links to an indoors setup some 1km away amongst the distant trees

continually fired from the transmitter.

Upon detection, data is organised for normal repeating to the distant RX, then the EN pin 3 is made "low" for snoozing again.

If nothing is heard the repeater's "lost" LED can be activated before the program loops.

Only small wiring changes are needed in the original repeater circuit – Dorji pins 3 (EN) and 5 (TXD) now run to PICAXE pins 3 (data in) and 4 (sleep/wake control).

This "machine gun" approach requires multiple sends of the data in the hope that the hibernating repeater awakens for a reception 'window' but was shown to be reliable and effective.

Current drains of under 1mA were noted during PICAXE and Dorji snoozing.

Depending on the 'SLEEP' duration (which very usefully can be determined at the transmitter) drains may now average just a few milliamps overall, while repeater battery life may be extended by around an order of magnitude or more (maybe to months).

A small solar panel and four NiCad/NiMH cells could now quite easily handle this load for a somewhat permanent installation.

A more tempting scheme could be to "ping" the repeater regularly, telling it to sleep unless fresh data was available.

Timing drifts may arise of course (as accurate time keeping is not available on a simple system) but a degree of synchronisation could develop if the repeater acknowledges TX commands before hibernating.

The Dorjis are transceivers after all, so a reply signal can confirm repeater compliance. A more sophisticated approach may be explored in a later constructional article.

Are 433MHz repeaters legal?

Regulations checks made with both the Australian and NZ spectrum licencing authorities (ACMA and RSM respectively) confirm that their regulations do not prevent establishment of a compliant 433.92MHz transmitter for repeater purposes.

Naturally the 25mW EIRP power limit regulation must still be respected but locally (at least) it's quite legal to set up the sort of private "store and forward" repeater that we've investigated here.

It's a wonder they've not been developed before!

Conclusion

These versatile and easy-to-use Dorji DRF7020D13-043A modules have shown themselves reliable performers and – given their excellent ranges – look ideal for many applications.

As a tribute to their likely appeal and keen prices, MicroZed reports initial stocks sold out within days! SC

Use of an elevated repeater can give enormous range boosts. Signals from a beachside house (about 1km below) were rebroadcast by this repeater and readily received some 10km away across the harbour. Not bad for 20mW! For extended use the repeater could be solar powered.

References

Code, circuitry, field trial findings, pictures and regulations etc, are conveniently hosted at www.picaxe.orcon.net.nz/dorji434.htm

Acknowledgement of assorted data sheets and diagrams from Dorji Applied Technologies (Shenzhen, China) is hereby made.

All other pictures and circuits are by the author, Stan Swan (Wellington,NZ) stan.swan@gmail.com

PCBs for Silicon Chip projects

Looking for a PCB to build that latest and greatest *Silicon Chip* project? Or maybe there's a project from an earlier issue that you've always been going to get around to! Now there's no excuse:

You can order the most recent projects' PCBs – and many older ones – direct from *Silicon Chip*.

Beautifully made, very high quality fibreglass boards with pre-tinned tracks, silk screen overlays and where applicable, solder masks.

Best of all, those boards with fancy cut-outs or edges are already cut out to the *Silicon Chip* specifications – no messy blade work required!

- **Most boards are IN STOCK and ready for despatch.**
- **Even if stock runs out (eg, for high demand), in most cases there will be no longer than a two-week wait.**
- **Always be guaranteed that the boards will be the latest versions with any modifications already done!**
- **One low p&p charge: $10 per order, regardless of how many boards you order! (Australia only; overseas clients – email us for a postage quote).**
- **New project boards will normally be available within days of the magazine on-sale date: no waiting!**
- **(Note: some copyrighted PCBs are not available).**

PROJECT	PUBLISHED	CODE	Price*
CHAMP: SINGLE CHIP AUDIO AMPLIFIER	FEB 1994	01102941	$5.00
PRECHAMP: 2-TRANSISTOR PREAMPLIER	JUL 1994	01107941	$5.00
HEAT CONTROLLER	JULY 1998	10307981	$25.00
SMART SLAVE FLASH TRIGGER	JUL 2003	13107031	$10.00
12AX7 VALVE AUDIO PREAMPLIFIER	NOV 2003	01111031	$25.00
POOR MAN'S METAL LOCATOR	MAY 2004	04105041	$10.00
BALANCED MICROPHONE PREAMP	AUG 2004	01108041	$25.00
POCKET TENS UNIT	JAN 2006	11101061	$25.00
STUDIO SERIES RC MODULE	APRIL 2006	01104061	$25.00
ULTRASONIC EAVESDROPPER	AUG 2006	01208061	$25.00
RIAA PREAMPLIFIER	AUG 2006	01108061	$25.00
GPS FREQUENCY REFERENCE (A) (IMPROVED)	MAR 2007	04103073	$55.00
GPS FREQUENCY REFERENCE DISPLAY (B)	MAR 2007	04103072	$30.00
KNOCK DETECTOR	JUNE 2007	05106071	$25.00
SPEAKER PROTECTION AND MUTING MODULE	JULY 2007	01207071	$25.00
CDI MODULE SMALL PETROL MOTORS	MAY 2008	05105081	$15.00
LED/LAMP FLASHER	SEP 2008	11009081	$10.00
USB-SENSING MAINS POWER SWITCH	JAN 2009	10101091	$45.00
DIGITAL AUDIO MILLIVOLTMETER	MAR 2009	04103091	$35.00
INTELLIGENT REMOTE-CONTROLLED DIMMER	APR 2009	10104091	$10.00
INPUT ATTENUATOR FOR DIG. AUDIO M'VOLTMETER	MAY 2009	04205091	$10.00
6-DIGIT GPS CLOCK	MAY 2009	04105091	$35.00
6-DIGIT GPS CLOCK DRIVER	JUNE 2009	07106091	$25.00
6-DIGIT GPS CLOCK AUTODIM ADD-ON	SEPT 2009	04208091	$10.00
STEREO DAC BALANCED OUTPUT BOARD	JAN 2010	01101101	$25.00
DIGITAL INSULATION METER	JUN 2010	04106101	$25.00
ELECTROLYTIC CAPACITOR REFORMER	AUG 2010	04108101	$55.00
ULTRASONIC ANTI-FOULING FOR BOATS	SEP 2010	04109101	$25.00
HEARING LOOP RECEIVER	SEP 2010	01209101	$25.00
TOSLINK TO S/PDIF/COAX CONVERTER	OCT 2010	01210102	$10.00
DIGITAL LIGHTING CONTROLLER SLAVE UNIT	OCT 2010	16110102	$45.00
HEARING LOOP TESTER/LEVEL METER	NOV 2010	01111101	$25.00
UNIVERSAL USB DATA LOGGER	DEC 2010	04112101	$25.00
HOT WIRE CUTTER CONTROLLER	DEC 2010	18112101	$25.00
433MHZ SNIFFER	JAN 2011	06101111	$10.00
CRANIAL ELECTRICAL STIMULATION	JAN 2011	99101111	$30.00
HEARING LOOP SIGNAL CONDITIONER	JAN 2011	01101111	$30.00
LED DAZZLER	FEB 2011	16102111	$25.00
12/24V 3-STAGE MPPT SOLAR CHARGER	FEB 2011	14102111	$25.00
SIMPLE CHEAP 433MHZ LOCATOR	FEB 2011	06102111	$5.00

PROJECT	PUBLISHED	CODE	Price*
THE MAXIMITE	MAR 2011	08103111	$25.00
UNIVERSAL VOLTAGE REGULATOR	MAR 2011	18103111	$15.00
12V 20-120W SOLAR PANEL SIMULATOR	MAR 2011	04103111	$25.00
MICROPHONE NECK LOOP COUPLER	MAR 2011	01209101	$25.00
PORTABLE STEREO HEADPHONE AMP	APRIL 2011	01104111	$25.00
CHEAP 100V SPEAKER/LINE CHECKER	APRIL 2011	04104111	$25.00
PROJECTOR SPEED CONTROLLER	APRIL 2011	13104111	$10.00
SPORTSYNC AUDIO DELAY	MAY 2011	01105111	$30.00
100W DC-DC CONVERTER	MAY 2011	11105111	$25.00
PHONE LINE POLARITY CHECKER	MAY 2011	12105111	$10.00
20A 12/24V DC MOTOR SPEED CONTROLLER MK2	JUNE 2011	11106111	$25.00
USB STEREO RECORD/PLAYBACK	JUNE 2011	07106111	$25.00
VERSATIMER/SWITCH	JUNE 2011	19106111	$25.00
USB BREAKOUT BOX	JUNE 2011	04106111	$10.00
ULTRA-LD MK3 200W AMP MODULE	JULY 2011	01107111	$25.00
PORTABLE LIGHTNING DETECTOR	JULY 2011	04107111	$25.00
RUDDER INDICATOR FOR POWER BOATS (4 PCBs)	JULY 2011	20107111-4	$80 per set
VOX	JULY 2011	01207111	$25.00
ELECTRONIC STETHOSCOPE	AUG 2011	01108111	$25.00
DIGITAL SPIRIT LEVEL/INCLINOMETER	AUG 2011	04108111	$15.00
ULTRASONIC WATER TANK METER	SEP 2011	04109111	$25.00
ULTRA-LD MK2 AMPLIFIER UPGRADE	SEP 2011	01209111	$5.00
ULTRA-LD MK3 AMPLIFIER POWER SUPPLY	SEP 2011	01109111	$25.00
HIFI STEREO HEADPHONE AMPLIFIER	SEP 2011	01309111	$45.00
GPS FREQUENCY REFERENCE (IMPROVED)	SEP 2011	04103073	$55.00
DIGITAL LIGHTING CONTROLLER LED SLAVE	OCT 2011	16110111	$30.00
QUIZZICAL QUIZ GAME	OCT 2011	08110111	$30.00
ULTRA-LD MK3 PREAMP & REMOTE VOL CONTROL	NOV 2011	01111111	$35.00
ULTRA-LD MK3 INPUT SWITCHING MODUL	NOV 2011	01111112	$25.00
ULTRA-LD MK3 SWITCH MODULE	NOV 2011	01111113	$10.00
ZENER DIODE TESTER	NOV 2011	04111111	$25.00
MINIMAXIMITE	NOV 2011	07111111	$10.00
ADJUSTABLE REGULATED POWER SUPPLY	DEC 2011	18112111	$5.00
DIGITAL AUDIO DELAY	DEC 2011	01212111	$30.00
DIGITAL AUDIO DELAY FRONT & REAR PANELS	DEC 2011	01212112/P2/3	$20 per set
CRYSTAL DAC	JAN 2012	01301121	$20.00
AM RADIO	JAN 2012	06101121	$10.00
STEREO AUDIO COMPRESSOR	JAN 2012	01201121	$30.00
STEREO AUDIO COMPRESSOR FRONT & REAR PANELS	JAN 2012	01201122/P1/2	$20.00
3-INPUT AUDIO SELECTOR (SET OF 2 BOARDS)	JAN 2012	01101121/2	$30 per set

***Note: P&P is extra ($10 per order). Prices listed** include GST **and are valid only for month of publication of this list; thereafter are subject to change without notice.** 01/12

AND NOW THE MICROS, TOO!

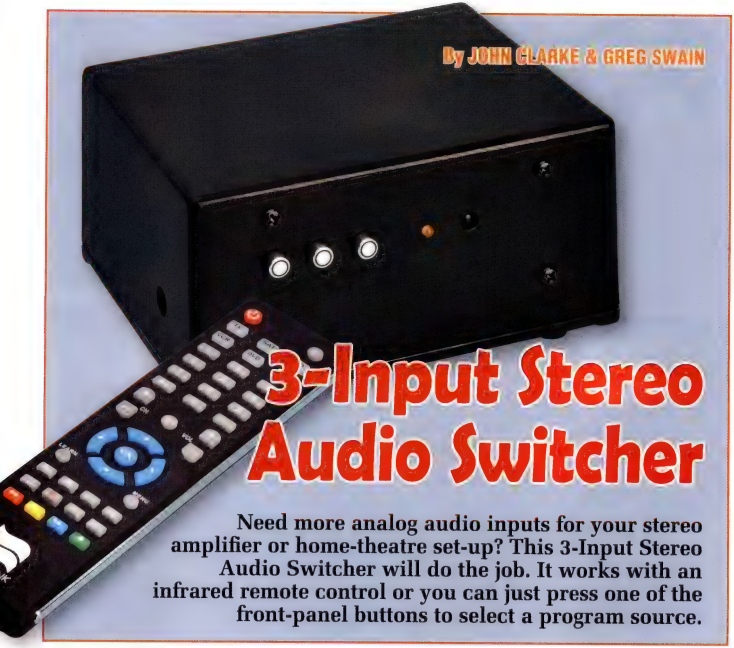
As a service to readers, *Silicon Chip* is now be stocking the vast majority* of microcontrollers and microprocessors used in new projects (from 2012 on) – **pre-programmed and ready to fly!**

Micros from copyrighted and contributed projects may not be available.

ORDER BY

- **PHONE:** (02 9939 3295, 9am-4pm Mon-Fri)
- **FAX:** (02 9939 2648, 24 hours/7 days)
- **EMAIL:** (pcbs@siliconchip.com.au, 24 hours/7 days)

By JOHN CLARKE & GREG SWAIN



3-Input Stereo Audio Switcher

Need more analog audio inputs for your stereo amplifier or home-theatre set-up? This 3-Input Stereo Audio Switcher will do the job. It works with an infrared remote control or you can just press one of the front-panel buttons to select a program source.

WHILE WE WERE developing the Input Selector board for the Ultra-LD Mk.3 Stereo Amplifier, we realised that we also had the basis for a self-contained project. All we had to do was move the PIC microcontroller to the main relay board, re-jig the circuit somewhat and house it in a metal case for shielding. That would give us a remote-controlled 3-Input Stereo Audio Switcher that would be ideal for use in any audio set-up.

In practice, it wasn't quite that easy because we also had to redesign the switch board to include the infrared receiver and an Acknowledge LED. And we had to re-jig the firmware in the micro to suit the reallocated I/O ports and to eliminate the remote volume control feature used in the Ultra-LD preamp.

As shown in the photos, the unit is housed in a metal diecast case which we spray-painted black. The switch board mounts on the front panel, while four pairs of stereo RCA sockets on the main PCB (three for the inputs and one for the outputs) protrude though holes in the rear panel. Power comes from a 9-12V plugpack and the unit typically draws less than 600mW.

Virtually any universal remote control can be used with the unit and there are three different "modes" (or devices) to choose from – TV, SAT1 & SAT2. The default mode is TV but SAT1 can be selected by pressing (and holding) button S1 during power-up. Similarly, SAT2 is selected by pressing button S2 at power-up, while pressing S3 at power up reverts to TV mode.

Of course, having selected a mode you must also program the remote with the correct code. We'll have more to say about that later on.

In operation, the unit lets you select between any one of three stereo analog inputs by pressing the "1", "2" or "3" buttons on the remote. Alternatively, you can press the buttons on the front-panel switch board.

An integral blue LED in each switch button lights to indicate the selected input. This occurs both when a button is pressed and when the remote control is used. The blue switch LEDs also serve as power indicators, while

Parts List

1 PCB, code 01101121, 101 x 81mm
1 PCB, code 01101122, 84 x 38mm
1 9-12V 300mA plugpack supply (eg, Jaycar MP3280, MP3146)
1 diecast aluminium box, 119 x 94 x 57mm (Jaycar HB5064)
3 DPDT 5V relays, PCB-mount (Altronics S4147)
1 4MHz crystal (X1)
1 18-pin machined DIL socket
4 PCB-mount gold-plated dual RCA sockets (Altronics P0212, Jaycar PS0280)
3 PCB-mount pushbutton switches with blue LEDs (S1-S3) (Altronics S1177, Jaycar SP0614)
8 M3 x 10mm tapped spacers
1 2.5mm PCB-mount DC socket (Altronics P0621A, Jaycar PS0520)
2 ferrite beads (L1, L2) (Altronics L5250A, Jaycar LF1250)
1 10-pin PCB-mount IDC header socket (Altronics P5010, Jaycar PP1100)
1 10-pin 90° PCB-mount IDC header socket (Altronics P5060, Jaycar PP1118)
2 10-pin IDC line sockets
1 100mm length 10-way IDC cable
9 M3 x 6mm pan-head machine screws
4 M3 x 6mm pan-head machine screws (black)
4 M3 x 10mm pan-head machine screws
4 No.3 x 10mm screws (black)
5 M3 nuts
9 M3 washers

Semiconductors

1 PIC16F88-I/P programmed with 0111211A.hex (IC1)
1 infrared receiver module (IRD1) (Altronics Z1611A, Jaycar ZD1952)
3 BC337 NPN transistors (Q1-Q3)
1 7805 5V regulator (REG1)
4 1N4004 diodes (D1-D4)
1 3mm orange LED (LED4)

Capacitors

2 100µF 16V electrolytic
1 10µF 16V electrolytic
1 100nF MKT polyester
2 470pF MKT polyester or MKP polypropylene (do not use ceramic)
2 22pF ceramic

Resistors

6 4.7kΩ
3 1.8kΩ
1 1kΩ
1 330Ω
7 100Ω

the orange Acknowledge (ACK) LED on the front panel flashes when ever a valid remote control signal is received.

By changing a couple of linking options, you can also build the unit so that it responds to buttons 4, 5 & 6 on the remote, or to buttons 7, 8 & 9 (ie, instead of 1, 2 & 3). You might want to do this if buttons 1, 2 & 3 have been allocated to another piece of equipment (eg, to the selector board in the Ultra-LD Mk.3 Stereo Amplifier) or if you want to build two such units and control them using the same remote.

Performance

By using relay switching and carefully designing the PCB (especially in regards to earthing), we've been able to achieve excellent specifications. The signal-to-noise ratio is >116dB unweighted relative to 1V RMS (20-22kHz bandwidth), while channel separation is 109db @ 1kHz and 90dB @ 10kHz. The THD+N (total harmonic distortion plus noise) is <0.0004% @ 1kHz (20Hz-22kHz), a figure that's basically below the measurement capabilities of our test equipment.

The interchannel crosstalk is -116dB @ 1kHz and -101dB at 10kHz (unused input terminated with 100Ω).

Suffice to say that this unit will have negligible impact on the audio signal being switched. As such, this unit would be ideal for use with the Class-A Stereo Amplifier which only featured one set of audio inputs. Or it could be used in any other audio or home-theatre set-up where you need extra analog inputs.

Circuit details

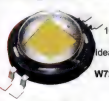
Refer now to Fig.1 for the circuit details. It uses 5V DPDT relays (RLY1-RLY3) to switch the three stereo inputs: Input 1, Input 2 & Input 3 (CON1-CON3). These relays are in turn controlled by NPN transistors Q1-Q3, depending on the signals from microcontroller IC1 (PIC16F88-I/P).

The incoming stereo line-level

RMS PARTS

Give your lighting projects a
SEOUL

LED Dazzler Kit
(As seen in SC Feb'11)
Drive up to 3 powerful P7 LEDs
Or most other high power LEDs
Includes all parts and PCB
LEDs not included
KIT-LED_DAZZLER $39.95 + GST



P7 Power LED
10W Pure White Emitter
Approx. 900lm @ 2.8A
Ideal for torch applications
PCB available to suit
W724C0-D1 $16.00+GST

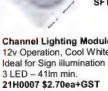
P4 Star 4W LEDs
Power LEDs mounted on 20mm Star PCB. Various Colours available.
Pure White W42182 $3.90+GST
Nat. White S42182 $3.90+GST
Warm White N42182 $3.90+GST

P3-II Star 2W LEDs
Power LEDs mounted on 20mm Star PCB. Various Colours available.
Pure White WS2182 $2.95+GST
Warm White NS2182 $2.95+GST

P5-II RGB Power LED
High power RGB LED mounted On 20mm Star PCB
Drive each colour @ 350mA
Ideal for wall wash applications
F50360-STAR $14.95+GST

SMD RGB LED
General purpose RGB LED in PLCC-6 package
Drive each colour @ 20mA
SFT722N-S $0.95ea+GST

Channel Lighting Modules
12v Operation, Cool White
Ideal for Sign illumination
3 LED – 41lm min.
21H0007 $2.70ea+GST
4 LED – 55lm min.
21H0008 $3.60ea+GST



VOLUME DISCOUNTS APPLY

SEOUL
SEOUL SEMICONDUCTOR

AUSTRALIAN DISTRIBUTOR

Ph. 07 3390 3302
Fx. 07 3390 3329
Email: sales@rmsparts.com.au
www.rmsparts.com.au

The rear panel carries the four RCA socket pairs, with the output pair at left.

inputs are connected to the NO (normally open) contacts of each relay. When a relay turns on, its common (C) contacts connect to its NO contacts and the stereo signals are fed through to the left and right outputs via 100Ω resistors and ferrite beads. The resistors isolate the outputs from the audio cable capacitance, while the beads and their associated 470pF capacitors filter any RF signals that may be present.

When button 1 on the remote (or on the switch board) is pressed, the micro switches its RA2 port (pin 1) high. This pulls the base of transistor Q1 high via a 4.7kΩ resistor and so Q1 turns on and switches on RLY1 to select Input 1 (CON1). Similarly, RLY2 & RLY3 are switched on via Q2 & Q3 respectively when buttons 2 and 3 are pressed.

The firmware in the micro ensures that only one relay can be on at any time. Pressing a button (either on the remote or the switch board) turns the currently-activated relay off before the newly-selected relay turns on. If the input button corresponds to the currently-selected input, then no change takes place. The last input selected is restored at power up.

Diodes D1-D3 protect Q1-Q3 by quenching the back-EMF when the relays switch off.

Pins 15 & 16 of the micro are the oscillator pins for 4MHz crystal X1 which is used to provide the clock signal. This oscillator runs when the circuit is first powered up for about 1.5 seconds. It also runs whenever a signal from the infrared receiver is received at its RB0 input or when a button on the switch board is pressed and then for a further 1.5 seconds after the signal ceases.

The oscillator then shuts down and the processor goes into sleep mode. This ensures that no noise is radiated into the audio signal paths during normal operation.

Power supply

Power for the circuit is derived from a 9-12V plugpack. This is fed in via reverse-polarity protection diode D4 to regulator REG1 which provides a +5V output. A 100µF capacitor filters the supply to REG1, while 10µF and 100nF capacitors decouple the output.

The +5V rail powers the microcontroller and the relays. In addition, this rail is also fed to pin 3 of CON5, while pin 5 of CON5 is connected to ground. This provides power to the switch board via the IDC cable and CON6.

Switch board circuitry

Fig.1 also shows the circuitry for the switch board. This includes the infrared receiver (IRD1), the three momentary contact pushbuttons with integral blue LEDs (LEDs1-3), the ACK (acknowledge) LED and the 10-way header socket (CON6).

The 38kHz infrared signals from the remote are picked up by IRD1 and demodulated to produce a serial data pulse train at its pin 1 output. This signal is then fed to the RB0 (pin 6) input of the PIC16F88-I/P (IC1) via pin 8 of headers CON6 & CON5. IC1 decodes the signal to determine the RC5 code sent by the remote and switches its RA2-RA4 outputs accordingly to select the corresponding input.

LED4 (ACK) flashes each time a valid code is received from the remote. It's driven by the RB4 output of IC1 via a 330Ω current-limiting resistor.

Power for IRD1 comes in via pin 3 of CON6 and is decoupled using a 100Ω resistor and a 100µF capacitor. This filtered +5V rail is applied to pin 3 of IRD1, while pin 2 connects to ground.

Button switches

Switches S1-S3 allow manual selection of the input. One side of each switch is connected to ground, while the tops of S1-S3 are pulled high (ie,

Changing The Remote Control Buttons

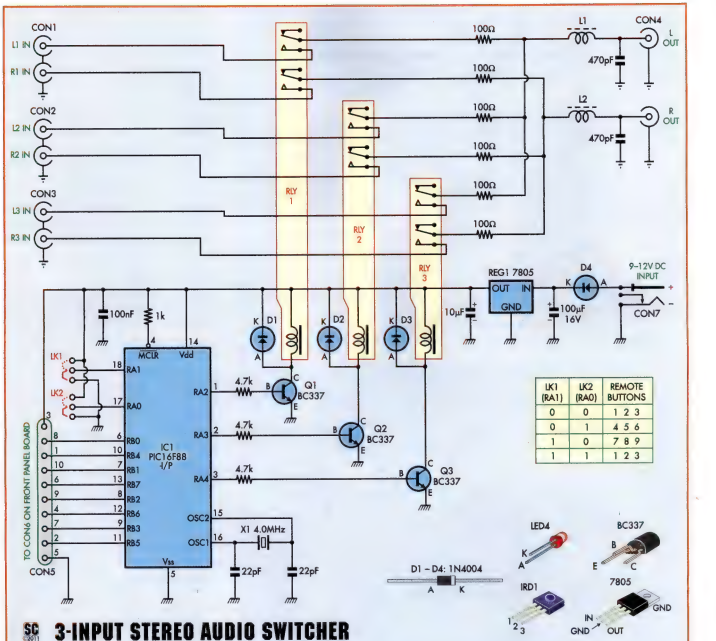
By changing the linking options on the PIC microcontroller, you can make the unit respond to buttons 4, 5 & 6 on the remote or to buttons 7, 8 & 9 (ie, instead of buttons 1, 2 & 3).

By default, pins 18 & 17 (RA1 & RA0) of the micro are tied to ground by two thin tracks on the PCB (the ground tracks runs down the centre of the IC, immediately to the left of these pins). As a result, both pins are at logic 0 (ie, they are both low) and the unit responds to buttons 1, 2 & 3 on the remote.

If you want the unit to respond to buttons 4, 5 & 6, cut the track between pin 17 and ground and connect this pin to the adjacent +5V pad (immediately to the right) instead. You can do this using a solder bridge or a short length of tinned copper wire.

Alternatively, to make the unit respond to buttons 7, 8 & 9, cut the link between pin 18 and ground and connect this pin to the +5V pad. Tying both pins 17 & 18 high (ie, at logic 1) restores button 1, 2 & 3 operation (ie, it responds to the 1, 2 & 3 buttons when both inputs are tied high or both tied low).

The truth table on the circuit diagram shows the various options. Just remember that a logic 1 represents a high (ie, +5V), while logic 0 represents a low (ie, ground).



LK1 (RA1)	LK2 (RA0)	REMOTE BUTTONS
0	0	1 2 3
0	1	4 5 6
1	0	7 8 9
1	1	1 2 3

SC 3-INPUT STEREO AUDIO SWITCHER

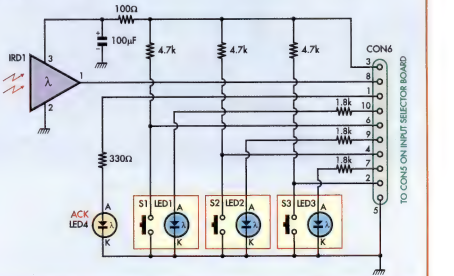


Fig.1: the circuit uses a PIC16F88-I/P microcontroller (IC1) to decode signals from an infrared receiver (IRD1) and pushbutton switches S1-S3. The micro then drives relays 1-3 via transistors Q1-Q3 to switch the selected input through to the stereo outputs at CON4. Diode D4 provides reverse polarity protection, while REG1 provides a regulated +5V supply.

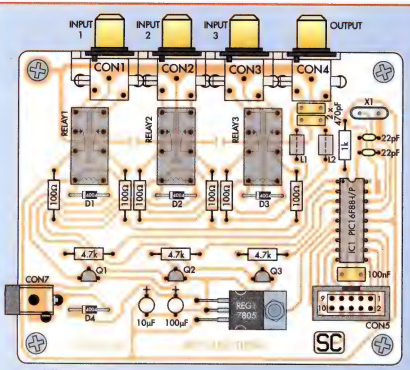


Fig.2: follow this diagram and the photo below to build the main PCB. Note that we initially used 470pF ceramic capacitors across the outputs but these were later changed to MKT types for lower distortion.

to +5V) via 4.7kΩ resistors and are respectively connected to the RB7, RB6 & RB5 ports of IC1.

Similarly, the cathodes of the internal blue LEDs (LEDs1-3) are connected to ground while their anodes are driven by ports RB1-RB3 respectively via 1.8kΩ current-limiting resistors.

When a switch is pressed, it pulls the corresponding port on IC1 low and this wakes the microcontroller up which then processes the data and turns on the corresponding relay. At the same time, either RB1, RB2 or RB3 switches high to light the appropriate switch LED. IC1 then promptly goes back to sleep again.

Construction

Fig.2 shows the assembly details for the main PCB while Fig.3 shows the switch board assembly.

Install the resistors and diodes D1-D4 on the main PCB first, then install the ferrite beads, an 18-pin IC socket for IC1 and the two 470pF MKT capacitors near CON4 (do not substitute ceramic capacitors). The two 22pF capacitors below crystal X1 can then go in, along with the 100nF capacitor and the two electrolytics (make sure that the latter are correctly orientated).

That done, install transistors Q1-Q3, crystal X1 and the 10-way header socket. The latter must go in with its slotted key-way towards IC1 (see photo). Regulator REG1 can then be installed and that's done by first bending its leads down through 90° to match the holes in the PCB. Its metal tab is then fastened to the PCB using an M3 x 6mm machine screw and nut, after which the leads can be soldered.

Capacitor Codes

Value	µF Value	IEC Code	EIA Code
100nF	0.1µF	100n	104
470pF	NA	470p	471
22pF	NA	22p	22

Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	6	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	3	1.8kΩ	brown grey red brown	brown grey black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	1	330Ω	orange orange brown brown	orange orange black black brown
❑	7	100Ω	brown black brown brown	brown black black black brown

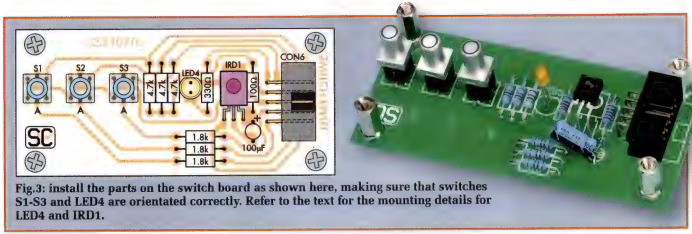


Fig.3: install the parts on the switch board as shown here, making sure that switches S1-S3 and LED4 are orientated correctly. Refer to the text for the mounting details for LED4 and IRD1.

Don't solder the regulator's leads before it's fastened into place. If you do, you could crack the PCB tracks as the mounting screw is tightened.

The main board assembly can now be completed by installing the DC socket, the relays and the four stereo RCA input socket pairs. Don't install the microcontroller (IC1) yet – that step comes later, after the power supply has been checked.

Once the board has been finished, fit a 10mm spacer to each corner as shown in Fig.6.

Switch board assembly

Start the assembly of this board by installing the resistors, the 90° 10-way header (key-way up) and the 100µF capacitor. **The latter should be installed with its body leaning by about 60° as shown in one of the photos, so that it won't later foul the front panel of the case.**

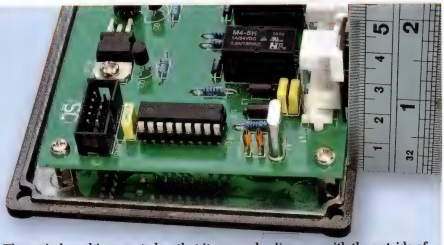
The three pushbuttons can now go in but note that they must be installed the right way around. These have kinked pins at each corner plus two straight pins for the integral blue LED. The anode pin is the longer of the two and this must go in the hole marked "A" on the layout diagram.

Once the pins are in, push the buttons all the way down so that they sit flush against the PCB before soldering their leads.

LED4 is next on the list and must be installed with its body exactly 10mm above the PCB. This can be done by pushing it down onto a 10mm-high cardboard spacer. Check that it's orientated correctly before soldering its leads – its anode lead is the longer of the two.

Infrared receiver

The infrared receiver (IRD1) must



The main board is mounted so that its rear edge lines up with the outside of the lip that runs around the inside edge of the base.

This view shows the switch board mounted inside the case, prior to the installation of the main board and base assembly.

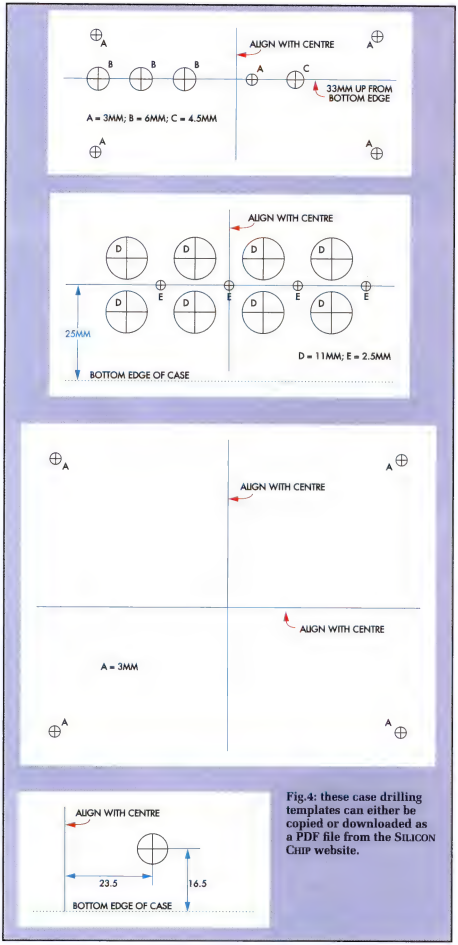


Fig.4: these case drilling templates can either be copied or downloaded as a PDF file from the SILICON CHIP website.

be installed so that its domed lens is aligned with LED1 and the switches. If you have the Jaycar unit, the first step is to bend its leads down by 90° exactly 5mm from its body. The device should then be installed with its body exactly 9mm above the PCB (use a 9mm spacer to set the height).

This will ensure that the surface around its domed lens rests against the inside of the case when the switch board is later mounted in position.

Alternatively, you can leave IRD1 out for the time being and mount it after the case has been drilled. If you elect to do that, it's just a matter of first pushing its leads through the PCB, then mounting the switch board in the case. The switch side of the case is then positioned face down, after which IRD1 is slid into position and its leads soldered.

The mounting arrangement for IRD1 is slightly different if you have the Altronics Z1611A part instead of the Jaycar part. The Altronics device comes with an integral metal shield and this shield must not come into contact with the metal case. Its body is also larger than for the Jaycar device.

To install the Altronics device, bend its leads down 3mm from its body, then install it so that the rear of the device is no more than about 5mm above the PCB. Check to ensure that its lens is aligned horizontally with the LED and the switches before soldering its leads.

The switch board assembly can now be completed by securing M3 x 10mm spacers plus M3 nuts (which act as additional spacers) to each corner – see Fig.6 and photo.

Drilling the case

The next step is to drill the case. Fig.4 shows the four drilling templates and these can either be photocopied or downloaded as a PDF file from the SILICON CHIP website. In each case, it's just a matter of aligning the blue lines with horizontal and vertical pencil lines marked on the case itself. The templates are then secured in place with sticky tape (see photo), after which you can drill the holes.

It's important to be accurate with the hole locations, so be sure to position each template carefully and to start each hole with a very small pilot drill (eg, 1mm). The holes can then be carefully enlarged to size.

You can use drills up to about 4mm but after that it's best to enlarge the

holes using a tapered reamer. This will have to be done for the switch holes, the RCA socket holes and the access hole for the DC socket.

It's easy to get the switch holes all the same size – just ream one out to the correct size, then push the reamer into the hole as far as it will go and wind some sticky tape around the outside where it meets the case. The other two holes are then reamed out up to the sticky tape.

The RCA socket holes are done in exactly the same way.

Note that the main PCB is not mounted centrally on the base but is offset by 3mm towards the rear. It's just a matter of drawing horizontal and vertical centre lines on the base and lining up the blue lines on the template with these before taping it into position.

Once the drilling is complete, deburr all holes using an oversize drill or a small rat-tail file. The case can then be spray-painted matte black (three or four thin coats are much better than one thick coat).

Making the IDC cable

Fig.5 shows how to make the IDC cable that links the two PCBs together. Note that pin 1 on the header sockets is indicated by a small triangle in the plastic moulding and the red stripe of the cable must go to these pins.

You can either crimp the IDC headers to the cable in a vice or use an IDC crimping tool (eg, Altronics T1540 or Jaycar TH-1941). Don't forget to fit the locking bars to the headers after crimping, to secure the cable in place.

Having completed the cable, check that the headers have been correctly terminated. This can be done by plugging them into the matching sockets on the PCBs and then checking for continuity between the corresponding pins at either end using a multimeter.

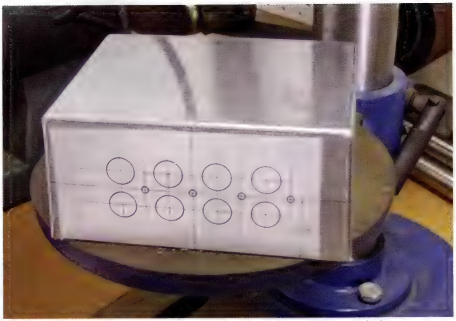
Initial tests

Before installing the PIC microcontroller, it's a good idea to check that the power supply is correct. To do that, connect a 9-12V DC plugpack, apply power and check the voltage between pins 14 & 5 of the IC socket. Pin 14 should be at +5V with respect to pin 5 (GND).

If you don't get any output from REG1, check the supply polarity and the orientation of D4.

Assuming the supply is correct, switch off, install the microcontroller and make sure the two boards are connected together via the IDC cable. That done, reapply power and check that one of the blue switch LEDs lights. You should also hear a click from the corresponding relay as it turns on.

Now try changing the input selection using the switches. Each time you press a button, its LED should light and you should hear the relays switch over. If there's no action, check that power is being applied to the switch board (the junction of the 4.7kΩ resistors should be at +5V with respect to ground).



The templates are secured to the case using sticky tape. Start all holes using a 1-1.5mm drill to ensure accuracy and enlarge holes over 4mm using a reamer.

Getting the remote working

The remote control function can now be tested using a suitable remote – eg, the Altronics A1012 ($19.95) and the Jaycar AR1726 ($37.95). As stated earlier, the default device mode programmed into the micro is TV but if this conflicts with other gear you can use SAT1 or SAT2 instead. Just press (and hold) button S1 at power-up for SAT1, button S2 for SAT2 or button S3 to revert to TV mode.

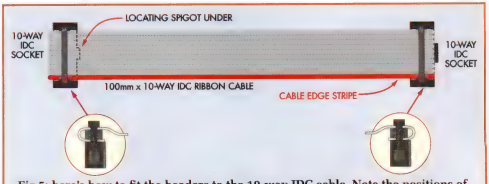


Fig.5: here's how to fit the headers to the 10-way IDC cable. Note the positions of the locating spigots on each header – they both face in the same direction.

The completed IDC cable should be tested by fitting it to the PCB assemblies and using a DMM to check for continuity between their matching pins.

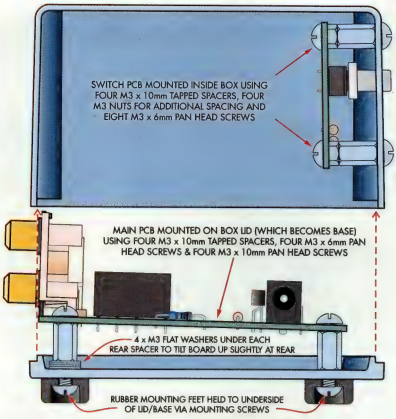
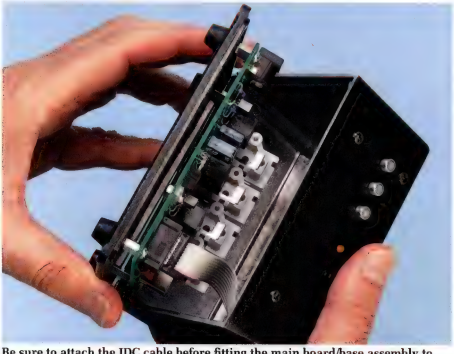


Fig.6: this cross-section diagram shows how it all fits together. The four M3 flat washers under the spacers at the rear tilt the board back slightly, so that the RCA sockets mate with the sloping wall of the case.



Be sure to attach the IDC cable before fitting the main board/base assembly to the case and installing the case screws.

Once you've chosen the "device" mode, you also have to program the correct code into the remote. For the Altronics A1012, use 023 or 089 for TV mode, 242 for SAT1 or 035 for SAT2.

Similarly, for the Jaycar AR1726, use 103 for TV, 1317 for SAT1 or 1316 for SAT2.

If you have some other universal remote, it's just a matter of testing the various codes for a Philips device until you find one that works (most Philips devices rely on the RC5 code standard).

Having programmed the remote, check that the inputs can be selected using the 1, 2 & 3 buttons. Each time a button is pressed, the orange ACK LED should flash and you should hear a "click" as the corresponding relay switches on. The blue LED in the corresponding switch button should also light.

If the ACK LED doesn't flash and there's no response from the relays, make sure that the remote is programmed correctly. Check also that the correct device has been selected (ie, TV, SAT1 or SAT2). The ACK LED won't flash at all unless everything is correct.

Final assembly

Once everything is working correctly, the unit can be installed into the case. Fig.6 shows the details.

The switch board is secured inside the case using four M3 x 6mm black pan-head screws from the outside. Plug the IDC cable into its header before fitting this board, then check that the switches operate freely, without fouling the edges of their holes. The ACK LED should just protrude through the case, while the Jaycar version of the infrared receiver lens should be against the case and the lens centred in its hole.

Alternatively, if you have the Altronics infrared receiver, it should sit further back so that its metal shield doesn't touch the case. A red perspex window glued to the inside of the case will improve the appearance.

The main board sits on the base of the case and is secured to it using four M3 x 10mm machine screws which also hold the rubber feet in place. **Note that the four M3 washers are also fitted under the spacers at the rear. This tilts the board back slightly so that the RCA sockets mate with the sloping wall of the case.** Don't forget to connect the IDC cable before fitting the assembly together and installing the case screws.

Finally, install the four No.3 x 10mm screws at the rear. These go into the plastic bodies of the RCA socket assemblies and secure them against the inside of the case, so that they are held fast when the cables are plugged in to the sockets. SC

SILICON CHIP
siliconchip.com.au

YOUR DETAILS

NEED PCBs?

You can get the latest PCBs direct from SILICON CHIP!

See p69 for full details . . .

Order Form/Tax Invoice

Silicon Chip Publications Pty Ltd
ABN 49 003 205 490
PO BOX 139, COLLAROY NSW 2097
email: silicon@siliconchip.com.au
Phone (02) 9939 3295 Fax (02) 9939 2648

This form may be photocopied without infringing copyright.

Your Name_____ (PLEASE PRINT)

Address_____

Postcode_____ **Daytime Phone No. (** **)**_____ **Email address** _____

Method of Payment: ❑ EFT (ring or email for details) ❑ Cheque/Money Order ❑ PayPal ❑ Visa Card ❑ Master Card

Card No. ❑❑❑❑ ❑❑❑❑ ❑❑❑❑ ❑❑❑❑ Card expiry date: ❑❑/❑❑

Signature_____

YOUR ORDER SILICON CHIP PRINTED EDITION SUBSCRIBERS# QUALIFY FOR 10% DISCOUNT (except on subscriptions!)

SIMPLY TICK THE ITEMS REQUIRED – DON'T FORGET TO FILL IN DETAILS ABOVE. WE'LL WORK THE TOTAL OUT FOR YOU AND SEND YOU A RECEIPT WITH YOUR ORDER

SILICON CHIP SUBSCRIPTIONS (all prices include P&P)

- ❑ AUSTRALIA 6 MONTHS (INC. GST) $52.00
- ❑ AUSTRALIA 12 MONTHS (INC. GST) $97.50
- ❑ AUSTRALIA 12 MONTHS WITH BINDER (INC. GST) $115.00
- ❑ AUSTRALIA 24 MONTHS (INC. GST) $188.00
- ❑ AUSTRALIA 24 MONTHS WITH 2 BINDERS (INC. GST) $222.00
- ❑ NEW ZEALAND 6 MONTHS (AIR MAIL) $AU55.00
- ❑ NEW ZEALAND 12 MONTHS (AIR MAIL) $AU99.00
- ❑ NEW ZEALAND 24 MONTHS (AIR MAIL) $AU196.00
- ❑ OVERSEAS (EXCEPT NZ) 6 MONTHS (AIR MAIL) $AU80.00
- ❑ OVERSEAS (EXCEPT NZ) 12 MONTHS (AIR MAIL) $AU140.00
- ❑ OVERSEAS (EXCEPT NZ) 24 MONTHS (AIR MAIL) $AU265.00

NEW! CONVENIENT AUTOMATIC SUBSCRIPTION RENEWAL:

❑ ick here if you'd like us to automatically renew your subscription when it elapses (ie, 6 month, 12 month or 24 month). We'll renew until you tell us to stop!

SILICON CHIP BACK ISSUES/ARTICLE PHOTOCOPIES

❑ **SILICON CHIP BACK ISSUES*; SC/EA/ETI PHOTOCOPIES**

– includes P&P – $12.00 within Australia; $15.00 overseas

*where in stock - photocopy of article supplied where issue is out of stock. EA/ETI: no back issues left, only photocopies available. Price is for each back issue or each article photocopy.

Nominate issue and article required: Month:..... Year:.....

Article required:.....

Please attach list if more than one back issue or photocopy required. There is a 10% discount for ten or more back issues and/or photocopies (no further discount applies).

SILICON CHIP MAGAZINE BINDERS

❑ **Embossed "SILICON CHIP", securely holds 12 months+ of issues**

Available in Australia only $14.95

PCBs, PANELS, PROGRAMMED MICROS

Many PCBs and panels, along with some pre-programmed microprocessors and microcontrollers are now available direct from SILICON CHIP.

See the separate page listing those currently available on page 69.

SILICON CHIP BOOKSHOP (P&P additional – See below)

❑ PERFORM. ELECT. FOR CARS PLUS ELECTRONIC PROJECTS FOR CARS (2003) – last few, some may be shop-soiled, – BOTH BOOKS ... ~~$21.95~~ now only $15.00

- ❑ AC MACHINES $66.00
- ❑ AMATEUR SCIENTIST CD NEWEST Version 4.0 ..... $62.00
- ❑ AUDIO POWER AMPLIFIER DESIGN – SELF ..... SAVE! Was ~~$114.00~~ $81.00
- ❑ BUILD YOUR OWN ELECTRIC MOTORCYCLE ..... ~~$47.95~~ $40.00
- ❑ DVD PLAYERS AND DRIVES ..... SAVE! Was ~~$85.00~~ $71.00
- ❑ ELECTRIC MOTORS AND DRIVES ..... ~~$60.00~~ $51.00
- ❑ NEWNES GUIDE TV & VIDEO TECHNOLOGY ..... SAVE! Was ~~$58.00~~ $49.00
- ❑ OP AMPS FOR EVERYONE ..... SAVE! Was ~~$110.00~~ $100. 00
- ❑ PIC IN PRACTICE $60.00
- ❑ PIC MICROCONTROLLERS - KNOW IT ALL ..... SAVE! Was $83.00
- ❑ PIC MICROCONTROLLER - PERSONAL INTRO COURSE $60.00
- ❑ PRACT. GUIDE TO SATELLITE TV (7th edition) $49.00
- ❑ PRACTICAL RF HANDBOOK ..... SAVE! Was ~~$73.00~~ $61.00
- ❑ PRACT. VAR. SPEED DRIVES/POWER ELECT. ..... SAVE! Was ~~$88.00~~ $73.00
- ❑ PROG. 32-BIT MICROCONTROLLERS IN C ..... SAVE! Was ~~$94.00~~ $79.00
- ❑ PROGRAMMING AND CUSTOMIZING THE PICAXE $65.00
- ❑ RADIO, TV AND HOBBIES ON DVD-ROM $62.00
- ❑ RF CIRCUIT DESIGN ..... SAVE! Was ~~$74.00~~ $63.00
- ❑ SELF ON AUDIO (2nd edition) ..... SAVE! Was ~~$82.00~~ $69.00
- ❑ SMALL SIGNAL AUDIO DESIGN ..... SAVE! Was ~~$103.95~~ $88.00
- ❑ SOLAR SUCCESS – GETTING IT RIGHT EVERY TIME $47.50
- ❑ SOLAR THAT REALLY WORKS $42.50
- ❑ SWITCH. POWER SUPPLIES A-Z (inc CD-ROM) ..... SAVE! Was ~~$108.00~~ $91.00
- ❑ TV ACROSS AUSTRALIA ..... SAVE! Was ~~$39.95~~ $39.00
- ❑ USING UBUNTU LINUX $27.00

***10% discount offer does not apply to online edition subscribers nor to website orders**

P&P RATES:

Subscriptions, back issues and project reprints: **P&P included**

Binders *(available Australia only)*: **$10.00 per order; for 5 or more P&P is free.**

Books: **Aust. $10 per order; NZ: $AU12 per book; Elsewhere $AU18 per book**

To Place Your Order:

eMAIL (24/7) silicon@siliconchip.com.au with order & credit card details

OR

FAX (24/7) This form (or a photocopy) to (02) 9939 2648 with all details

OR

PAYPAL (24/7) Use PayPal to pay *silicon@siliconchip.com.au*

OR

PHONE - (9-5, Mon-Fri) Call (02) 9939 3295 with your credit card details

OR

MAIL This form to PO Box 139, Collaroy NSW 2097

*ALL ITEMS SUBJECT TO AVAILABILITY. PRICES VALID FOR MONTH OF MAGAZINE ISSUE ONLY. ALL PRICES IN AUSTRALIAN DOLLARS AND INCLUDE GST WHERE APPLICABLE.

New Year. New Gear.

SAVE $100

$499

Atten® Q 0200

25MHz R&D Digital Storage Oscilloscope

Perfect for those in R&D, product development or service of complex electronic equipment. Features 2 channels with real-time 500MS/s sampling. The colour 5.7" TFT display screen can be set up to simultaneously display the waveform plus indicate the measured wave voltage, peak to peak plus RMS, frequency, duty cycle etc. Realtime adjustments via PC can be made of the scope using included software. Stored data can be saved to a USB stick or downloaded to a PC. PictBridge™ printer compatible.

32 auto measure parameters | Math functions | Compact case

Protek® TRUE RMS Datalogging DMM

The full house multimeter, packed with features and value! Excellent for research, design & service.

Features: • Dual display with bargraph • Decibel capacitance, inductance & temperature • Alarm, clock & stop watch • Pulse signal injection • MIN, MAX, AVG & relative modes • Logic test • Continuity & diode test • Fused 20A input • Data hold & run.

SAVE $50

$129 Q 1098

Get an accurate measurement in seconds!

This laser tape measure provides an instant 'one touch' measurement - up to 30m. Excellent accuracy down to just ±3mm. Plus calculation modes such as add, subtract, pythagorean, square & cubic measurements.

NEW! T 2251

$199 Ideal for tradespeople!

includes handy beltpouch | Metric/imperial | Auto off

Jumbo Display 28 Range DMM

Includes temperature probe at no extra cost! Excellent for the service technicians or enthusiast.

• Data hold • 20A rated • AC/DC to 1000V • Auto power off • Temperature • Frequency.

SAVE 20%

$55 Q 1067

NO MORE EYE STRAIN!

The Original INSPECT-A-GADGET.

30% OFF

Let "gadget" be your eyes. Identify those impossible to read miniature components, without straining your eyes. Great for stamp & coin collectors, model makers, jewellers etc.

Features an ultra-bright Philips triphosphor fluorescent tube for extra crisp, clear view.

THOUSANDS SOLD!

SAVE 30% $82 A 0970A 3 Dioptre

SAVE 30% $90 A 0971 5 Dioptre

$99 NEW MODEL! T 2416

The T 2443 replacement has landed!

Micron® 45W Digital Soldering Station

An excellent multi purpose soldering iron for service technicians, schools, engineers, R&D, production work etc. Japanese ceramic element for long life. 150° to 480°C. 0.8mm tip. **May be used with mini-wave tips, see below.**

Suits lead free soldering | Burn proof rubber lead | All metal case

Mini-Wave Soldering Tips

These fine concave tips allow hand flow soldering of surface mount devices such as chip caps, resistors, SOIC & PLCC packages. Suits T 2416 & T 2418.

NEW! $23.95ea Great for SMD work!

1.0mm	T 2471
2.0mm	T 2472
3.0mm	T 2473

Nifty Tablet Desk Stand

Adjustable, universal aluminium benchtop stand for tablets & e-Readers. A must have for hands free web surfing, reading recipes and watching movies. Non-slip rubber feet. *iPad for illustration purposes.

NEW! $24.95 H 8250 Perfect for iPads*

See Inside Walls, Pipes & Conduits...

...with this handheld inspection camera & 2.4" LCD monitor. Great for accessing difficult locations such as wall cavities, ceiling spaces, pipework & industrial machinery. Requires 4xAA batteries for camera. Includes case.

Great for mechanics, plumbers and installers

S 8742 NEW $169

'See-Through' Parts Storage

Great way to tidy up your work bench - with room for all your parts, test leads, nicknacks and doohickeys!

H 0237: 347Wx142Dx187H

H 0239: 447Wx180Dx246H

H 0237 Small H 0239 Large

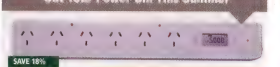
SAVE 25% $29 SAVE 25% $44 Add drawer dividers for $4.95 pk/20

1W LED Headband Torch X 0199

1W superbright 60 lumens white LED, plus 4 LED work lamp. Flashing mode for cyclists. Requires 3xAAA batteries. So light, you'll barely know you've got it on!

SAVE 22% $19

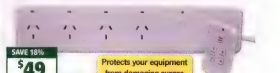
Cut Your Power Bill This Summer



SAVE 18% $49 P 8134 Displays the real $ cost of running appliances.

Monitor energy consumption & cut standby power use.

Handy powerboard with in-built energy meter to calculate running costs. It also helps to lower your power bill by cutting standby power to 'slave' devices when a 'master' appliance is turned off. All outlets are surge protected up to 30,000 amps!



SAVE 18% $49 P 8119 Protects your equipment from damaging surges

Switch devices off at the outlet & reduce your power bill

4 way remote power board with surge protection. Turn appliances off at the touch of a button. 50m RF range. Includes battery.

3 Channel Energy Meter

This wireless home energy monitor can log power usage on up to 3 mains outlets around the house. Includes channel 1 plug in sensor & base station. 30m range. Displays usage in kW/h or currency.

SAVE 20% $38

P 8137

Extra Transmitters | P 8138 Ch. 2 | P 8139 Ch. 3 | $19.95

ALTRONICS
ONE-STOP ELECTRONICS SHOP

Our 'One-Stop' Electronic Enthusiast Centres...

Perth WA: 174 Roe St
Balcatta WA: 7/58 Erindale Rd
Auburn NSW: 15 Short St
Springvale VIC: 891 Princes Hwy

Holiday Security Deals

SAVE $70
$215
S 9430
Day & Night Recording

In-Car Camera & Video Recorder
• Records full motion video & audio to a 8GB Compact Flash (CF) card • Set and forget automatic recording • Ideal for fleet vehicles • Instant evidence when analysing accidents, damage, driver assaults, etc • Includes software & power lead.

S 9902A pictured.

Now with remote smartphone monitoring

$599 NEW MODEL

Just add a hard drive and go!

Affordable D-I-Y CCTV Surveillance Packages
Great size for a small business or family home. Simply add a hard drive (see right) and plug it in! Each pack includes: • 4 channel H.264 digital video recorder • 4 pro grade cameras • 4 x 20m BNC & power combo leads • Power splitter lead • Power supply • Easy to follow instructions.
S 9900A includes 4 x weatherproof dome cameras. S 9901A includes 4 x weatherproof bullet cameras. S 9902A includes 2 x bullet cameras & 2 x dome cameras.

4 Channel H.264 recording | Weatherproof cameras | Live smartphone viewing | Motion triggering

Seagate® Hard Drives To Suit

D 5513A	1TB	$180
D 5515	2TB	$239

Colour TFT Video Door Intercom
• A safe & easy way to monitor the front door. • Ultra-sharp 7" colour screen • Records photos of visitors when you're not home • USB/SD photo, video & MP3 playback • Includes power supply, hookup cable, base station & camera unit • Remote door latching* • Expandable to 4 base stations & 2 cameras.

SAVE $50
$299
S 9406

Added security for the family!

Extra base station	S 9407	$299
Extra outdoor camera	S 9409	$99
Optional door strike	S 5385	$44.95

*When used with optional door strike S 5385

Also shoots 5 megapixel stills

S 9446
NEW!
$299

Covert Surveillance DVR Camera
Great for monitoring in remote locations. Compact weatherproof unit contains camera, movement detector, DVR with SD card slot and battery pack (requires 8xAA). Monitor screen may be plugged in on-site for quick footage review. Ideal for trail scouting & wildlife/livestock monitoring.

SAVE 20%
$55
S 9440

Portable Mini Digital Video Recorder
Fits right in your pocket and records audio and video to the included 4GB micro SD card. Great for security personnel. Recharges via USB. 640x480 resolution. Just 74mm high!

NEW!
$139
X 2810

Remote Control Open/Closed LED Sign
High brightness long life LED sign with remote control & flashing mode. Includes power supply and hanging chains. Size: 170H x 410W x 50Dmm.

SAVE $20
$79
S 9359
Lower interference than 2.4GHz!

5.8GHz Wireless AV Sender
Great for wireless CCTV! • Transmit stereo audio & composite video without cables from one room to another. • 30m range • Works with Fosté! • Infrared sender built in • Includes transmitter, receiver & plugpacks.

SAVE $30
$119
S 9423
Install yourself & save!
120° view | 2.5" colour screen | Waterproof camera

Colour Reversing Camera & Monitor
A must have for hassle free reversing! The vibrant screen mounts discretely to your dash, while the camera fits into the rear bumper number plate recess. Includes a 5m connection lead. Hooks up to the reversing lights, powering up when required.

Super compact!

S 8761
NEW!
$49.95

Wireless video for your vehicle reversing camera
The ideal cable free solution for reversing cameras on trailers & caravans. Incredibly easy to install. Use anywhere cabling for a camera is impractical. 12V power input (use in-line with your camera).

4 Core Security Cable
For connecting alarm sensors, PIR's etc. Full 100m rolls only.

SAVE 22%
$35/roll
W 2341

SAVE $35
$250
D 0882A
Power & phone/data protection

Protect your CCTV system from power failure, surges & spikes.
Powershield Defender 1200VA. Provides power backup when mains fails, plus added protection for surges and spikes on power & data lines. Backup time for 4 ch. CCTV system: 17mins.

SAVE $100
$329
S 9331
Advanced MPEG compression

'All In One' DVR & Monitor Unit
4 channel DVR with 7" folding LCD monitor. Provides switching, quad processing and recording functions all in one. Records up to 4 cameras (at 25 frames per second max) to an internal hard drive - see above. Includes power supply & software for Win XP/7.

IP68 rated for ultimate outdoor protection.
S 9140C
SAVE 20%
$55

Super Light At Night!
Infra red illuminator. Extends your camera's night time IR range by up to 30m. Features 15 high output IR led's housed inside a waterproof aluminium case. Requires 12VDC plugpack (M 9272B $17.95).

BARGAIN!
$4.95
P 0606

Easy Power Termination
Lights up a LED to indicate polarity, AC or DC input. 5-30V AC/DC input. 800mm fly lead. Great for CCTV hookup.

New AV Gear For Summer

Add Wireless Audio Streaming to any Amp!

This non-descript 'little black box' connects directly into your amplifier via stereo RCA sockets and streams audio from Bluetooth devices within 10m range.

A must have for the music lover! Stream audio to your current home theatre system from your smartphone or Bluetooth® equipped laptop.

Wireless 30W Bluetooth® Amplifier

Simply hook up a pair of speakers and stream audio from your Bluetooth® smartphone, tablet or laptop up to 10m away. Wired inputs also provided. RS-232 remote control input, plus infra-red remote volume, bass & treble adjustment. Includes remote control, IR target & power supply.

Slim Monitor/TV Bracket

Just 19mm deep! Mount small TVs & monitors to a wall. 75/100/200mm mounting holes. 25kg max.

Remote Control Extender

30m range! Relay IR remote control signals from one room to another.

Redback® DAB+ Digital FM Tuner

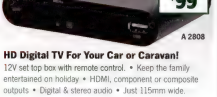
This stylish digital DAB+ radio tuner provides instant access to local digital FM stations. All stations and settings can be easily accessed via the front LCD screen and jog dial. • 10 digital and 10 FM station presets • S/PDIF & RCA outputs. • Remote control • Size: 430 x 256 x 76mm.

NEW Mini 4 Zone 30W Amplifier

Ideal for multi-zone audio distribution. Offers 30W RMS per zone (15W per/ch) all from a unit measuring just 200mm wide! Individual volume controls. Headphone output. RCA input. Includes power supply.

Dynalink® Infra-Red Extender Kit

Great for controlling equipment when its located inside cabinets or entertainment units. Kit includes hub, infra-red target, four infra-red emitters and power supply. Foxtel compatible (non IQ only).



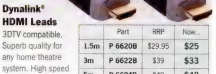
HD Digital TV For Your Car or Caravan!

12V set top box with remote control. • Keep the family entertained on holiday. • HDMI, component or composite outputs • Digital & stereo audio • Just 115mm wide.

180W Subwoofer Sensation!

Add cinema like realism to your home theatre sound system. Massive 180W 10" driver with built in amp. A stunning frequency response of 35Hz-1KHz. Level, phase & crossover control built in.

"Best value subwoofer we've used. Even compared to brand name models costing twice as much" - Ashley, Retail Music Systems



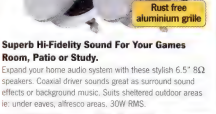
Dynalink® HDMI Leads

3DTV compatible. Superb quality for any home theatre system. High speed HDMI with Ethernet (V1.4). Lifetime warranty.

	Part	RRP	Now...
1.5m	P 6620B	$29.95	$25
3m	P 6622B	$39	$33
5m	P 6624B	$49	$42
10m	P 6626B	$89	$79
15m	P 6628B	$139	$119

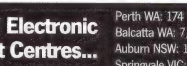
Long Distance HDMI Sender

Send 1080i HDMI signal up to 55m over 2 lengths of Cat5e. Includes transmitter, receiver & plugpacks. 1080p 30m.



Superb Hi-Fidelity Sound For Your Games Room, Patio or Study.

Expand your home audio system with these stylish 6.5" 8Ω speakers. Coaxial driver sounds great as surround sound effects or background music. Suits sheltered outdoor areas ie: under eaves, alfresco areas. 30W RMS.



Woodgrain In-Ear Headphones

Stylish woodgrain finish with 3 sets of silicon ear cups for high noise isolation. Superb sound for a great low price!

Finally, a decent pair of wireless headphones!

We've evaluated many models for our catalogue since 1998, the C 9031's are the first we'd be happy to buy for ourselves. Superb low noise digital transmission. USB dongle can be used with a PC or without a PC - ie: connect directly to an MP3 player. 30m range.

Digital TV Panel Antenna

Provides 25dB gain for clear digital TV & radio reception. Includes power supply & PAL to F lead. Indoor or sheltered outdoor installation. Size 190x118mm.

"Picture Hanging" TV Bracket

It may look like a bunch of obscure parts, but it is in fact a nifty television bracket, allowing you to hang your TV up on a wall or cabinet as if it were a picture. Suits 32-55" TV's. 50kg max.

DIY Electronics...

Also available in individual modules - see our website for details

Silicon Chip 2x20W Stereo Class-A Amp Kit

The latest ultra low distortion 2x20W RMS class-A amplifier from Silicon Chip. With a THD specification of just 0.0006% it can barely be measured even on pro grade test equipment! A pure Class-A design for audiophiles to enjoy. Includes all components required to construct a fully built amp.

Smart Fan Controller Kit

(SC July '10).

This compact module regulates the speed of up to eight 12V fans. Measures up to 4 temperature points & smoothly controls fan speed. May be monitored using PC software. Ideal for computers, greenhouses, home breweries, amp cooling etc.

Voice Operated Switch Kit

Ideal for voice controlled automation projects. (SC July '11). Triggers relay contacts whenever a sound is made with fully adjustable sensitivity & on-time. Optional manual override. Includes mic insert. Requires 12V DC.

Semiconductor Teaching Chips

Developed by Edinburgh University. This package of see through chips, prototyping board and guide are invaluable for learning about how semiconductors operate.

Improve Your Hearing Without Expensive Aids!

(SC Sept '10) Hearing Loop Receiver Kit. Picks up signals from a hearing loop (or T-coil), found in PA systems at places of worship and function centres. It even works with home made hearing loops. Requires 9V battery (S 497) $5.95).

Special Function 12V Timer Kit

(SC October '08) A handy timer module designed to accept a trigger input from a rising or falling voltage. When triggered the timer can switch devices on for any period between 0.1s and 16.5 minutes.

Motor Speed Controller Kit For Power Tools

(SC February '09) Suitable for appliances rated up to 10A. Suits brush-type universal motors such as those in small lathes, electric drills, circular saws, routers, nibblers and jigsaws.

Mini-Maximite BASIC Embedded Module Kit

(SC November '11) The 'little brother' of the Maximite kit. Utilising identical software it is designed as an intelligent controller for embedding into larger systems. Features 20 I/O pins, 128K RAM, VGA/composite out, USB2.0 & keyboard interfaces. All from one low cost IC!

Ultra LD Mk.2 200W Class AB Amp Pack

Top quality sound at an affordable price!

(SC Aug '08) This design runs much cooler than class A amplifiers, yet offers similar tiny levels of distortion (around 0.0083%!). 135W RMS into 8Ω or 200W into 4Ω.

PACK INCLUDES	
K 5151	Amp Module Kit
H 0945	Heatsink
K 5153	Power Supply Module
MC5540	Toroid Transformer

Web Server In A Box (WIB) Kit

(SC Nov '09) Host and update your own website without the need for a computer! This compact box houses a chip based server that may be accessed anywhere in the world - even from a mobile phone. Beyond serving web pages, it also monitors & logs 4 analog inputs, or control 4 digital outputs.

20A Motor Speed Controller Kit

(SC June '11) This gutsy little speed controller has a wide range of applications and is simple to build and use. • Low-battery protection • Soft start • Adjustable pulse frequency. • Runs from 12V or 24V batteries at currents of up to 20A.

Resellers:

WESTERN AUSTRALIA

Bunbury	ML Communications	(08) 9721 9800
Esperance	Esperance Communications	(08) 9071 3344
Geraldton	ML Communications	(08) 9965 7555

VICTORIA

Beaconsfield	Electronic Connections	(03) 9768 9420
Benalla	Leading Edge Electronics	(03) 5762 2710
Castlemaine	Top End Technology	(03) 5472 1700
Clayton	Rockby Electronics	(03) 9562 8559
Cranbourne	Bourne Electronics	(03) 5996 2755
Croydon	Truscott's Electronic World	(03) 9723 3860
Geelong	Music Workshop	(03) 5221 5844
Healesville	Amazon DVDs Healesville	(03) 5962 2763
Leongatha	Gardner Electronics	(03) 5662 3891
Melton	Melton Electronics & Comms.	(03) 9743 1233
Nunawading	Semtronics	(03) 9873 2555
Painesham	Get Smart Hifi	(03) 5941 4886
Preston	Preston Electronics	(03) 9484 0191
San Remo	Shoreline Electrical Wholesalers	(03) 5678 5361
Somerville	AV2PC	(03) 5978 0007
Stawell	David O Jones Mitre 10	(03) 5358 1205
Warrnambool	Multicomm IT & Comms.	(03) 5561 5111
Wodonga	Exact Computers & Home Ent.	(02) 6056 5746

TASMANIA

Hobart	Active Electronics	(03) 6231 0111
Launceston	Active Electronics	(03) 6334 7333

QUEENSLAND

Brisbane South	Delsound	(07) 3397 8155
Brisbane North	Prime Electronics	(07) 3252 7466
Cairns	Pentacom	(07) 4032 1710
Cloncurry	Access Electronics	(07) 4742 2599
Gold Coast	Prime Electronics	(07) 5531 2599
Hervey Bay	Ultra Music	(07) 4128 2037
Innisfail	Leading Edge Electronics	(07) 4061 6214
Longreach	Access Electronics	(07) 4658 0500
Maryborough	Leading Edge Electronics	(07) 4121 4559
Rockhampton	Access Electronics	(07) 4922 1058
Rockhampton	Home Delivered Computers	(07) 4928 2555
Toowoomba	Michael's Electronics	(07) 4632 9990
Townsville	Solex	(07) 4771 4211

NEW SOUTH WALES

Brookvale	Brookvale Electrical Distributors	(02) 9938 4299
Cessnock	Leading Edge Electronics	(02) 4990 5971
Cobar	Cobar Electronics	(02) 6836 2962
Deniliquin	Wired Entertainment	(03) 5881 3555
Gloucester	Autolec Gloucester	(02) 6558 1600
Grafton	Downes Electronics	(02) 6642 1911
Griffith	Griffith Systems Plus	(02) 6964 5933
Gunnedah	Protronics	(02) 6742 2100
Lithgow	Leading Edge Electronics	(02) 6352 3330
Nth Richmond	Candle Power Technologies	(02) 4571 4699
Oak Flats	Oak Flats Electronics	(02) 4256 6120
Orange	Fordray Electronics	(02) 6362 9901
Penrith	Penrith Light and Sound	(02) 4733 3333
Port Macquarie	Fettel Communications	(02) 6581 1341
Raymond Terrace	Leading Edge Electronics	(02) 4987 4909
Smithfield	Chatsworth	(02) 9609 7218
Tamworth	Bourke Street Electronics	(02) 6766 4664
Taree	Noeledge Systems Pty Ltd	(02) 6551 3622
Wagga Wagga	Wagga Car Radio & Hi-Fi	(02) 6925 6111
Waterloo	Heries Electrical Supplies	(02) 9319 3133
Wetherill Park	Techtron Electronics Pty Ltd	(02) 9604 9710
Windang	Mad Electronics	(02) 4297 7373
Wyong	Coastal Caravan and RV Pty Ltd.	(02) 4353 1100

SOUTH AUSTRALIA

Adelaide	Aztronics	(08) 8212 6212
Brighton	Force Electronics	(08) 8377 0512
Enfield	Aztronics	(08) 8349 6340
Findon	Force Electronics	(08) 8347 1188
Mt Barker	Classic Lights & Electronics	(08) 8391 1133
Milton	Leading Edge Electronics	(08) 8682 4911
Port Augusta	Spencer Electronics	0407189343

NORTHERN TERRITORY

Darwin	Combined Communications	(08) 8942 0644

NEW ZEALAND

Christchurch - Riccarton	Global PC	+64 3 3434475
Christchurch - Shirley	Global PC	+64 3 3543333

Sale Ends January 31st 2012

Altronics One-Stop Electronic Shops Phone 1300 797 007 Fax 1300 789 777

Mail Orders: C/- P.O. Box 8350 Perth Business Centre, W.A. 6849

© Altronics 2011. E&OE. Prices stated herein are only valid for the current month or until stocks run out. All prices include GST and exclude freight and insurance. See latest catalogue for freight rates. All major credit cards accepted.

B 0880

You don't have a computer handy . . . so,

How do you play music tracks on USB Sticks or SD/MMC Cards?

by Ross Tester

Do you ever wish you could simply play music tracks that you've saved on a USB stick or memory card? We had a particular reason for developing this project but it could easily be incorporated into your home hifi system for real convenience!

The "Quizzical" game adjudicator (described in SILICON CHIP in September 2011) included a module designed to play MP3 music files – we used it to provide a different sound for each quiz contestant, one which could be changed as required.

As often happens, this project started us thinking about another possible use for the module – that of playing music files "on demand" from an SD or MMC card, USB stick, etc, without resorting to playing them through a PC.

First, a bit of background. The idea for this came from a colleague who manages a public hall, often used for wedding receptions, 21st birthdays and even corporate and public meetings.

More often than not (especially for receptions and birthdays) those using the venue wanted to play music files through the hall's PA system.

If they provided them on an MP3 player with headphone output, no drama – the PA had been rigged with a "line in" terminated in a 3.5mm plug.

But just as often, someone would produce a USB stick (or sometimes a memory card) and ask if they could play the music they'd stored on those.

The manager usually obliged by plugging in his laptop computer and using that to read the stick or card. But apart from the security risk of leaving his laptop when he wasn't there, it was a lot of mucking around. It also meant he couldn't use his laptop that day or evening!

He'd seen the Quizzical and asked if there was some way its MP3 ability could be adapted to provide this "service".

And then we thought, why not go one step further? If you mounted a plate containing one of these modules on (or even in) a convenient wall and connected it to your hifi system or home theatre amplifier, you'd have five-second plug-in convenience if you ever wanted to play music you'd previously saved on a USB or SD! And a lot of people want to do exactly that!

Not exactly practical

On closer examination we decided the module used in the Quizzical, a TDB380 from Tenda Electronics, was not really suitable. Sure, it would read the files stored on an SD card – but it needed some "smarts" (eg, the rest of the Quizzical!) in order to select the right track(s) and so on.

Not only that, it didn't have other features that we really wanted: a USB interface, for instance, nor would it take an audio input if someone did bring along their MP3 player (or even

The three USB/SD/Audio modules we obtained from Tenda Electronics. All have the same function but the size differs.

Here's what we did with two of the three modules. At left, the TD898 module fitted to a blank power point plate. It has the advantage of a front-mounted "audio in" socket. The hole in the plate is for an IR receiver (all come with remote controls). At right is the TD896 module mounted in a small box – it's our fully portable version. We chose this module because of its overall small size.

their own cassette recorder). The TDB380 would need quite a lot of work and additional circuitry to bring it up to the mark. Scratch that idea.

But wait . . . they have more!

Then we found that Tenda Electronics had several other modules which appeared to do exactly what we wanted – not only that, these modules had the "smarts" built in to select tracks, fast forward and reverse, play and pause, even volume controls (handy for selecting different levels for background music and dance music).

Some also had LCD displays to tell you what was happening. All even had small built-in audio amplifiers, though these would not be needed for our original application.

Another bonus: they came with remote controls, although given the penchant for hall hirers to walk off with these in their pockets (as they do with the door keys!), this might be regarded as a mixed blessing. . .

The best part is the modules were cheap as chips – the whole module sold for less than we could have purchased just the USB and card readers here in Australia.

Oh, did we forget to mention? Tenda Electronics is, like the vast majority of electronics suppliers these days, in China. More on that anon.

We reasoned that we could not only provide what was needed pretty-much "off the shelf" merely by providing appropriate connections, we might also have the germ of another simple SILICON CHIP project – a fully portable USB/SD/MMC/audio player.

And this could even take advantage of the inbuilt amplifiers to give either headphone or speaker outputs.

So this little feature is the outcome. It's not a constructional project because 95% of the work is already done for you. Basically, all we are doing is showing you how to connect to the modules and some mounting ideas.

What data?

Unfortunately, the information on Tenda's website (like arguably the majority of Chinese manufacturers!) leaves a lot to be desired.

Not only is it out of date (there are differences between the current modules and the website) the information is scant, to say the least.

Which module?

Not knowing exactly what we wanted, we ordered three different Tenda modules from the variety on offer. It appeared to us that any one of them would be capable of the tasks required and that proved to be case – although one proved to be the best of the lot.

The modules we ordered were the Tenda models TD866, TD896 and TD898. The first two have the LCD readouts mentioned earlier; the last one does not but it does sport a front panel 3.5mm audio input socket. While the first two provide audio inputs on the PCB, they need to be connected to.

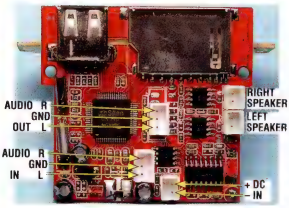
In the end, we decided the TD898 would be the best for the hall, despite not having an LCD readout. For our portable player, we decided on the TD896 – mainly due to its smaller size.

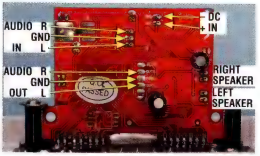
You can order these modules direct from Tenda (www.tendaelectronics.com) but they will set you back $50 each by the time you include freight. Or you can order the TD896 or TD898 modules from SILICON CHIP for $33.00 each plus $10 p&p. Prices include GST. (parts@siliconchip.com.au)

JST connectors

Unfortunately, all three modules use JST (Japan Solderless Terminals) connectors, which look like a miniature header socket (see photos). These connectors are often used in computers and computer peripherals.

The leads which mate to these connectors might be solderless when manufactured but we found they pulled apart too easily when simply crimped, so we used a "belt'n'braces"





Here are same-size top and bottom views of the TD896 module showing connections – the top side if you wish to use JST connectors and the bottom side if you wish to solder direct to the pads underneath. The speaker connections can be ignored if you don't want to use headphones or speakers.

approach and (carefully!) soldered the wires after we'd crimped them.

We used strands of ribbon cable to make up the connectors. Strictly speaking the audio input and the output to the amplifier should be shielded cable but for this length, ribbon cable is OK and a whole lot easier to handle.

We've got to say that making up these connectors has to be one of the most fiddly tasks ever devised – even under a large magnifying glass and bright light it was a real chore. So much so that with 20/20 hindsight, we'd either solder direct to the PCB (on the back of the JST connector) or we'd buy ready-made JST header leads.

That's not the easiest thing to do either – they're not something you can walk into your local lolly store and buy.

It's also not particularly easy to buy the bits to make the leads up. So we have decided to import limited quantities of these and also make them available through the SILICON CHIP parts shop – the 2-wire JST cables (100mm long, bare one end) are $3.45 each (inc GST) and the 3-wire are $4.50 each (inc GST) – all prices plus postage.

Portable player

Our first "project" using these modules – actually the TD896 – is a semi-portable music player. It's small enough to go anywhere but needs a 3.7V (or 5V) DC power supply to operate.

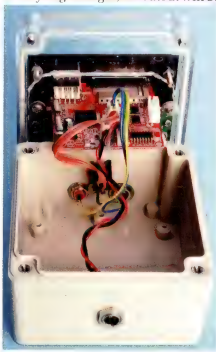
We considered making it battery-operated for complete portability but reasoned that most applications – at least in our experience – would have access to power.

First decision was the case into which we mounted the module. It's reasonably small at 75 x 55mm but the deciding factor is the depth – at 50mm it's too deep to fit into most small cases (they seem to be 38 or 45mm deep).

We decided on an Altronics H-0302 Sealed ABS Enclosure which measures 85 (w) x 80 (d) x 55mm (h) – the width and height are just enough. We happened to use one with a clear polycarbonate lid; this is not a requirement and the standard grey lid would be fine.

The first step in construction was to mount the module on the lid – this requires a little surgery to the lid. Exact position isn't critical but make sure it is centred left to right.

We used a small cutting wheel mounted on a Dremel-type drill – it might not be the neatest job in history but if you get it right, the cutout will be completely hidden by the front panel. Take "baby steps" – keep enlarging the cutout a millimetre or so at a time until the module just fits through.



And here's how it fits into the Altronics H-0302 box. The DC input socket is in the foreground, while the audio input (3.5mm socket) and audio output (2 x RCA sockets) are on the rear wall. Otherwise everything mounts onto the front panel.

The supplied self-adhesive label should be left until the very last, just in case you need to take the module out again (the label will cover the screws when secured in place).

Next, drill the holes in the bottom of the case for your power socket (8mm), RCA output sockets (9mm each) and the earphone/speaker 3.5mm socket (7mm).

We placed the power socket on the bottom end of the box and the three output sockets on the top but you can place them where you want.

Taking note of the polarity of the power JST connector, solder the power socket to a 2-pin JST lead, then use two more 2-pin JST leads to connect to the audio output sockets (note which pin is ground on the JST sockets; the two audio output socket grounds connect together to this wire).

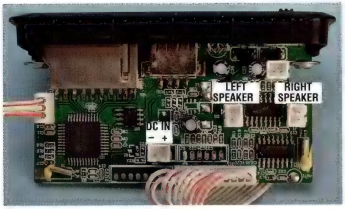
Finally, connect a 3-pin JST connector to the earphone/speaker socket (again, centre pin is ground).

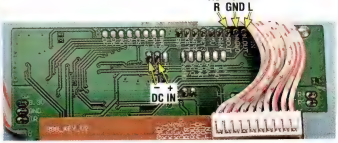
Now plug the JST connectors into their appropriate sockets on the PCB and you're just about ready to rock and roll.

Power supply

The Tenda literature says either 3.7V or 5V DC – we've taken a punt on 3.7V because we found a label that said so! Until proven otherwise, we'll stick with that!

Fortunately, 3.7V power supplies are quite common these days – many mobile phones use them and given the fact that there are several million more mobile phones in Australia than people, we're assuming there will be a fair number of surplus power supplies as well. Even if you have to buy one,





The TD898 module does not have a JST connector on the front for audio out – you need to solder to the appropriate pads on the rear of the board. Fortunately, all pads are quite clearly marked. DC in can be via a front JST connector or it too can be soldered to the pads.

it's not likely to cost a King's ransom!

Just watch the polarity when you connect it up – it's most usual to have the centre pin positive but we've certainly seen exceptions. The PCB is clearly marked.

The original request – amplifier music input

Connections, JST leads etc are similar to the portable player, except that we ignore the on-board stereo amplifier. Of course, if you want to use the amplifier for you application, go right ahead!

After dithering about with various mounting arrangements for a couple of weeks, we finally hit on one which we think makes sense. The difficulty, once again, was finding something deep enough which could be mounted on a wall.

We were restricted in our options because the unit needed to be mounted on a solid masonry wall skinned by Gyprock. Hence the module had to be mounted proud of the wall with enough depth to suit. (The Tenda TD898 module requires 43mm clearance).

We actually used two products to get the depth needed. First, a standard 37mm-deep power point mounting block (HPM 140P), on top of which we mounted an 11mm-deep power point mounting plate from an HPM XL770/0 plate and cover kit. Together, that gives us 48mm depth.

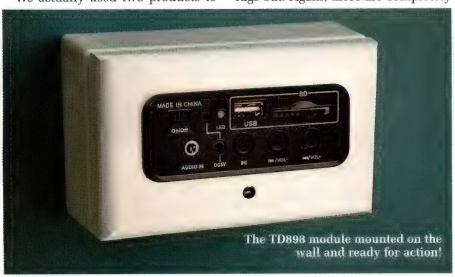
We could have mounted the Tenda module directly on the plate but it looks rather ugly. So the module itself mounts on the blank cover plate which comes with the HPM XL770/0.

The beauty of this particular blank plate is that it clips onto the mounting plate – no screws required. (While we used HPM, there's nothing to stop you using an equivalent product in another brand eg, Clipsal, etc).

Naturally, you'll require a cutout in both the mounting plate and the blank plate to suit the module – our cutout was 87 x 33mm right in the centre.

This creates something of a problem – the lugs for screwing the mounting plate to the block have to be removed to get the module to fit.

We overcame this by using a couple of self-tapping screws though the outer pair of holes left after cutting the lugs out. Again, these are completely covered once the plate housing the module is snapped into place.



The TD898 module mounted on the wall and ready for action!

Termination

As the wires to the JST connectors are quite flimsy (they're only ribbon cable, after all), we wanted to make a more robust connection for both power and audio out (to amplifier). To this end, we cut a scrap of old PCB to an appropriate shape and mounted a 5-way mini terminal block on it – two for power, three for audio [L, GND & R).

This arrangement suited us but you might come up with some other way of protecting the fine ribbon cable and connector.

Connecting to your amplifier

If you are running into a stereo amplifier, simply connect the left and right "audio out" to an "Aux" input via twin shielded cable.

If you are running into a PA or similar (mono) power amplifier, you need to combine the left and right channels into a single mono input. Ideally, there should be some resistance – say 1kΩ – in each line to isolate them from each other but we've never had a problem shorting left and right to mix them.

Mounting within the wall

Because we are using standard power outlet fittings, it follows that if you have a standard stud/Gyprock wall, you could mount the module almost entirely within the wall cavity for a less obtrusive, much neater finish.

For example, as long as there is sufficient space in the cavity you could eliminate the 140P mounting block and simply have the XL770/0 block fixed to the wall using a power outlet support clip or plate.

Then your USB/SD module, mounted on its blank plate, would simply clip into place on that block. SC

PRODUCT SHOWCASE

GW Instek GPT-9800 Series AC/DC/IR/GB Electrical Safety Tester from TekMark

The GPT-9800 Series of safety testers, recently introduced by TekMark, are designed to meet a variety of safety standards such as IEC, EN, UL, CSA, GB, JIS and other safety-related requirements.

There are four models in the series, with the top-of-the-range GPT-9804 (pictured), a 4-in-1 model capable of performing AC and DC withstanding, insulation resistance and ground bond tests.

The series is based on a high-efficiency PWM amplifier with 200VA AC maximum output capacity, to minimise the influence from voltage fluctuation of the input AC source. This ensures a stable voltage supply for all tests.

A combination of hardware and software controls is used to improve safety; eg, a self-check is performed to make sure all the functions and operations are under normal condition each time when the tester is turned on; the Zero Crossing Turn-On design avoids the impact of surge voltage output and the output voltage is automatically cut off (within 150µs) when abnormal output voltages have been detected or when the upper or lower current limits have been reached during testing.

To protect the operator from injury, the GPT-9800 Series automatically discharges the DUT after test (within 200ms) each time to eliminate excessive voltage that remains on the DUT. To further ensure safety, the interlock key can also be used as double protection to prevent inadvertent operation.

They are equipped with a simple & clear panel layout, a high resolution dot matrix LCD display and colour LED indicators.

All major test functions, including AC withstanding (AC 5kV/40mA), DC withstanding (DC 6kV/10mA), insulation resistance (DC 50V ~ 1000V) and ground bond (AC 30A max.) tests are performed under a high-stability voltage output with high-resolution measurement results.

Optional RS-232C, USB and GPIB interfaces are available for PC remote control and test result logging.

Contact:
TekMark Australia Pty Ltd
Suite 302, 18-20 Orion Rd, Lane Cove 2066
Tel: 1300 811 355 Fax: (02) 9418 8485
Website: **www.tekmarkgroup.com**

Jaycar's low cost, dual-mic UHF wireless microphone

Jaycar Electronics have added a two-microphone model to their range of wireless mics – at a significantly lower price than most comparable systems.

It's UHF (not the now-illegal VHF models now being flogged off dirt cheap online) and because two microphones are supplied, two people can talk at the same time. Outputs are individual channel XLR or mixed 6.35mm (a 1m 6.35 to 6.35mm plug lead is included, along with power supply).

Claimed range is 60m but our testing dramatically exceeded this – to 150m+!

Retail price is $199.00 (Cat No AM4078).

Contact:
Jaycar Electronics (all stores)
PO Box 107, Rydalmere NSW 2116
Order Tel: 1800 022 888 Fax: (02) 8832 3188
Website: **www.jaycar.com.au**

Prime Electronics – LED replacement for existing lamps

Ever since technology reached the point where it seemed that LEDs might offer a good alternative to traditional lighting, Prime Electronics has taken a leading role in developing and stocking an increasing range of such products.

While a few users incorporate LED components into finished products, most customers are seeking either a stand-alone fixture or simply a drop-in replacement for an existing "light bulb".

The challenge has been to produce products which fit into existing light fittings and to make them affordable, technically acceptable and compatible with existing dimmers, etc.

Technical advances in the last 12 months have now resulted in products which can replace most existing light sources, from the humble GLS "light bulb", to MR16 and GU10 dichroic halogen lamps and fluorescent tubes. The light output and light quality (in terms of colour temperature and CRI) is now comparable with existing technology. Controllability, in terms of compatibilty with dimming systems and automation systems, is now equal to traditional technologies.

Of course, the known benefits of LED lighting in terms of long life, much reduced power consumption and low heat have been retained and even improved, making LED lighting a serious contender as we strive to reduce energy consumption.

For more information, contact Prime Electronics showrooms on 07 3252 7466 (Brisbane), 07 5531 2599 (Gold Coast), or 02 9704 9000 (Sydney) or visit their website.

Contact:
Prime Electronics Pty Ltd
The Brickworks, Warehouse Rd Southport 4152
Tel: (07) 3252 7466 Fax: (07) 3252 2862
Website: **www.prime-electronics.com.au**

Where do you buy magnetic stirrer "fleas"?

Home Brewers and readers of SILICON CHIP December 2011 will have found the feature on making your our magnetic stirrer quite interesting.

The article mentioned the need to use a stir bar or "flea". But where can you buy such an item?

Wiltronics is a wholesale science and technology supply company with on-line web shopping. Fleas, or spinners for magnetic stirrers, are one of the many lines available from Wiltronics.

The spinner is a small bar magnet encapsulated in a PTFE plastic jacket and has a centre pivot point for low friction rotation.

A basic spinner sells for $4.95 ea.

Contact:
Wiltronics Research Pty Ltd
Unit 4, Cnr Ring Rd & Sturt St Ballarat Vic 3350
Tel:(03) 5334 2513 Fax:(03) 5334 1845
Website: **www.wiltronics.com.au**

Site-Log data loggers

Microedge Instruments have a range of stand-alone data loggers for recording input signals from sensors, transducers, transmitters or other common voltage sources. The loggers record up to 4Mb of data and store it in non-volatile flash memory for later retrieval. Battery life is 5-10 years (depending on the model)

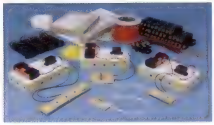
Mounted in a small aluminum enclosure and with conformal coated PCB, the Site-Log data logger has excellent performance in the harshest industrial environment.

Featuring a 16-bit ADC and programmable input ranges, they are well suited to science and laboratory applications where precise and accurate measurement is critical.

Available from Ocean Controls; prices start from $419.00+GST.

Contact:
Ocean Controls
PO Box 2191, Seaford BC, VIC 3198
Tel: (03) 9782 5882
Website: **www.oceancontrols.com.au**

TechCard: science meets art



TechCard answers those basic mechanics or electrics questions that primary and lower secondary school kids can build, without using a soldering iron or other dangerous implement – or breaking the school budget.

Here we have something that bridges the creative gap between science and art and is economical enough for every student to have a "hands-on take-home" experience. This is in stark contrast with the traditional practice of students having to dismantle their completed project for the parts to be recycled.

The basis of the system is a set of pre-cut, scored and punched card components that are simply folded and glued to form an infinitely variable range of girders, beams and bases. The overall dimensions and grid of pre-punched holes make accurate model building remarkably easy, for "Design and Make" and prototyping. Further, by inserting springs into these holes, component leads and wires may be "pinched" between the coils to build simple control circuits.

The structural elements are complemented by a complete range of mechanical components including wheels, axles, pulleys and gears, steering gear, pneumatic systems and propellers. Electrical components to go with the TechCard systems include battery holders, buzzers, motors lights and solderless connectors using springs.

Each kit is supplied with all necessary components and assembly directions. In most cases all the user needs to supply is PVA glue. Instructors are supported by the TechCard Teachers book.

Contact:
Kitstop Retail Systems
PO Box 5422, Clayton Vic 3168
Tel: 0432 502 755
Website: **www.kitstop.com.au**

VAF speakers now available in kit form

SILICON CHIP readers can now buy the famous VAF DC-Series loudspeakers as ready-to-assemble kits. These speakers provide exceptional sound in any room.

With twin silk tweeters, cooled Kevlar woofers and double chamber woofer cabinets they provide pure clean bass to under 25Hz and ultra-realistic soundstage delivered by perfect time alignment and diffraction control. Sensitivity is over 95dB/W @1m.

They can be used with small audiophile stereo amplifiers through to the most powerful of home theatre receivers, and the extended bass allows most owners to live happily without a subwoofer.

The entire DC-Series encompasses the DC-X floor standers, their smaller siblings the DC-7, the perfectly matched DC-Xcc and DC-6cc center speakers, and the compact DC-3 universal loudspeaker.

With a 10-year warranty, they're priced from $325 each to $2,699 pair and kits can be ordered with or without prefinished cabinets. Cabinet finishes include crown-cut book-matched Black Oak, American Cherry or Tasmanian Blackwood veneers and are hand finished in premium two-pack satin lacquers.

They are only available direct from VAF Research. SC

Contact:
VAF Research Pty Ltd
52-54 North Terrace, Kent Town SA 5067
Freecall 1800 818 882 Fax: (08) 8363 9997
Website: **www.vaf.com.au**

Vintage Radio

By Rodney Champness, VK3UG

The AWA PA1002 50W PA Amplifier

Boasting a power output of 50W RMS, the AWA PA1002 is a typical valve PA amplifier from the mid-1960s. It's a rugged, well-made unit with many useful features and is easy to troubleshoot and restore.

THE VERY FIRST PA systems used a straight tapered funnel arrangement, referred to as a bull horn, megaphone or loudhailer, without any form of electronic amplification. They certainly "reinforced" the user's voice to some extent but they were quite directional.

When valves later became readily available, PA amplifiers capable of a few watts were quickly developed. Those early units were used with carbon microphones, while the speakers were larger, more powerful versions of the horn speakers used with early receivers. Horn speakers were very efficient compared to modern loudspeakers but their frequency response was quite restricted and the distortion from these units was relatively high.

As a result, early PA systems were only suitable for voice communication.

PA amplifiers of various output powers were later used during World War II, some so big that they used radio transmitter valves in their output stages to feed the loudspeakers. By contrast, the commercial PA amplifiers used for the general public following the war were quite modest, with output powers ranging from around 5W up to about 25W.

As an aside, when I first worked in the radio service industry in the late 1950s, my employers hired out a PA system. This used a 25W amplifier (similar to the unit described here) and was teamed with a dynamic microphone, a record-playing turntable and up to four reflex-horn speakers. The speakers could be located some distance from the amplifier, as the output was fed to a 100V (medium impedance) speaker line.

The connecting cable consisted of a length of twin-lighting flex which had low losses at the speaker impedances used. Standing under the speakers when the unit was operating at full power was a deafening experience and it could be heard up to 3km away (depending on wind direction).

AWA PA1002 PA amplifier

My vintage radio collection includes several valve PA amplifiers, the largest of which is the AWA PA1002, a 50W unit from the mid-1960s. PA amplifiers improved considerably after World War 2 and top-end 50-100W valve PA amplifiers quickly reached the pinnacle of their development.

Unfortunately, I had no luck in obtaining a circuit diagram for the PA1002 although I do have circuits of other AWA PA amplifiers of the era. AWA obviously experimented with many different circuit designs because none of the circuits I have are anything like the PA1002. As I result, I eventually traced out the output and driver circuits of the amplifier and this revealed a push-pull output stage that's quite different to what's normally expected. In addition, the chassis has holes punched for two additional output valves, so that a 100W version could be manufactured using as much common circuitry as practical.

The amplifier itself weighs a hefty 14kg without any accessories and it measures 430 x 230 x 230mm (W x D x H), not allowing for the knobs and mounting feet. A feature of the unit is that there is plenty of room on top of the chassis for accessories, such as

a monitor speaker and a radio tuner. These accessories are not fitted as standard but could be easily added as their connection sockets are already wired.

As can be seen from the photos, access to the parts for service (or restoration) is relatively easy. To gain access to the valves, it is only necessary to remove four screws from the ends of the chassis that hold the U-shaped perforated steel cover in place. It is then quite practical to carry the amplifier by one or both of the metal rods located at the top of the cabinet that attach the front and back panel to the chassis.

The circuitry under the chassis is accessed by turning the unit upside down and then removing the four self-tapping screws holding the rubber buffers and the bottom shield in place, followed by the baseplate itself. It's then quite easy to access most of the parts although some parts are tucked in under a ledge at the back.

The bottom of the cabinet is fitted with rubber anti-scuff buffers and there are also ventilation holes in the bottom cover sheet.

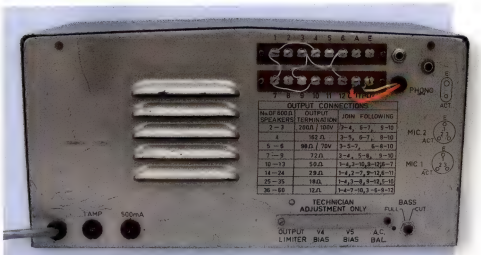
Inputs & controls

The PA1002 has inputs for two microphones and these are plugged into sockets on the lefthand end panel of the chassis. Another socket adjacent to these connects to the record player.

The various controls are conveniently located along the bottom edge of the front panel and (from left) include a volume control for each microphone plus another volume control for a record player or the optional radio tuner. These latter two units are selected by a phono/radio switch.

To the right of this is a tone control for the phono/radio channel, a small pilot light (for power) and an optional mains on/off switch, although the latter is not fitted to my unit (the hole location is "blanked off"). The final control is the monitor on/off switch but in my unit, someone in the past has rewired it to serve as the mains on/off switch.

In fact, none of the available accessories are fitted to my particular amplifier. However, the top section of the front panel has provision for their controls. At the left is a blanked-off hole that's intended to accommodate the dial for the radio tuner but the purpose of the blanked-off hole in the centre of the panel is a mystery. The perforations on the right are for the optional monitor speaker.



The patch terminals on the rear panel allow the amplifier's output to be matched to many different impedances for both 100V and 75V lines and are connected according to the table. In addition, there are two line output terminals plus antenna and earth terminals for the optional tuner.

An old exponential horn speaker as used in many PA systems during the 1960s. Similar speakers are still used in modern PA systems.

Rear panel facilities

A patch panel on the rear allows the amplifier's output to be matched to many different audio line impedances. There are 12 patch terminals in all and these are connected in various combinations according to a table.

There are also a couple of terminals and a couple of sockets to which the speaker lines are connected. Another two terminals are provided for an antenna and an earth for the tuner.

The bottom edge of the rear panel carries a number of controls and other features. At the left is the mains power lead, followed by a 1A mains fuse and then a 500mA high-tension fuse. An adjacent covered panel conceals four screwdriver adjustable preset controls: (1) signal limiter adjustment; (2) bias adjustment for the V4 output valve; (3) bias adjustment for V5; and (5) an AC balance control to null any residual hum in the audio output.

Finally, at extreme right is another screwdriver adjustable control. This is simply a 2-position switch which is labelled "Audio Bass Full/Cut". It very effectively removes any residual hum in the output.

Circuit details

Fig.1 shows the output section of the circuit. It's quite conventional in many areas but as mentioned above, the push-pull output stage is different to other circuits.

The two microphone outputs are fed to each half of a 12AU7 twin triode which amplifies these signals. Its outputs in turn drive the input of an EF86 signal limiter via level control potentiometers and mixing resistors. The signal from the radio tuner or the record player is also fed to this stage, again via a potentiometer and mixing resistor.

The EF86 signal limiter operates as follows. First, a small amount of the audio output is used to drive a small lamp and this illuminates an LDR (light dependent resistor) sealed inside a small lightproof tube. The LDR is connected across the grid resistor of the EF86 (see Fig.1), so the actual grid resistance decreases as the audio input increases.

Basically, the EF86's grid circuit has the LDR and its grid resistor in

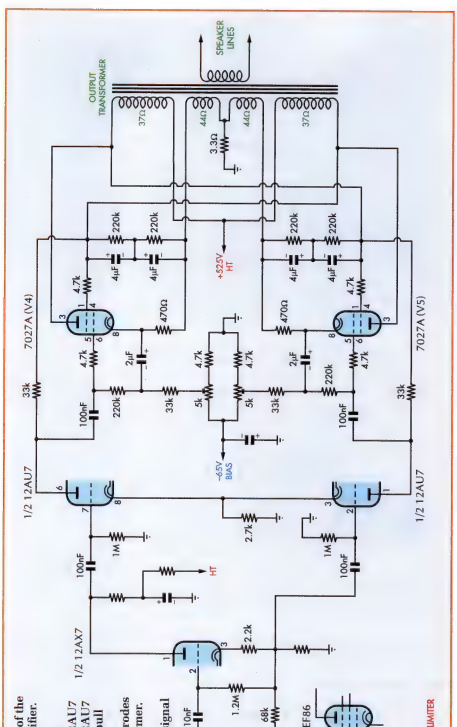


Fig.1: the output stage of the AWA PA1002 PA amplifier. The 12AX7 serves as a phase splitter and this drives a twin-triode 12AU7 amplifier stage. The 12AU7 in turn drives a push-pull output stage based on 7027A beam power tetrodes and an output transformer. The circuit segment at bottom left shows the signal limiter.

series with the resistors in the input-combining network. As a result, the LDR-resistor combination acts like an electronic volume control and even if someone bellows into a microphone, the amplifier will not be overloaded (assuming that the signal limiter is set up correctly).

By contrast with this arrangement, some PA amplifier circuits use an AGC voltage to control the EF86, even though it is a sharp cut-off valve. This involves altering the operating conditions for the EF86.

The next stage consists of a twin-triode 12AX7, with the first section used as an audio amplifier and the second section as a phase splitter. A twin-triode 12AU7 amplifier stage follows, with one section driving valve V4 and the other driving valve V5, both 7027A beam power tetrodes which form the push-pull output pair.

Most amplifiers of this type use the phase splitter to directly feed the two output valves in push-pull. However, in this amplifier, a higher input level is required for the output stage than such an arrangement could provide, as the output valves have quite a high negative bias applied to their grids (about -56V each). Hence the inclusion of the 12AU7 twin-triode stage.

The 7027A valve is an upgraded version of the older 6L6G and when used as a pure class-A single-ended amplifier, its operating conditions are almost identical. In this circuit, the bias for each valve is obtained separately from the bias supply so that it can be adjusted for performance variations between the individual valves.

Output transformer

The output transformer has a total of eight windings: four to match the output to the speaker line impedance plus another four in the plate/screen and cathode circuits. Each cathode winding has a resistance of around 44Ω, while the plate windings are about 37Ω.

It appears that the circuit has been designed with considerable negative feedback to stabilise it against the wide impedance variations reflected back into it from the long speaker lines. It's certainly an unusual circuit but it works very well. However, I do wonder why they went to so much trouble when a more conventional circuit would have done the job, as with many of AWA's other designs.

The power supply (Fig.2) uses a solid-state voltage-doubler circuit and this has an output of +525V DC with the high mains voltage (250V) at my place. The bias is obtained from a separate half-wave solid-state rectifier, which gives a maximum of -65V DC. As well as the windings shown in

Fig.2, the transformer also has a 6.3V heater winding with two 47Ω resistors across it to give an artificial centre-tap to earth, ie, one end of each resistor goes to the chassis.

Finally, the unit includes a circuit that artificially injects hum into the amplifying chain to cancel out and minimise hum in the output.

Restoration

Three badly overheated resistors were the most obvious fault when I removed the bottom cover from the amplifier. Two were on the screens of the 7027A output valves, so it was quite possible that these had also been damaged after such abuse.

This sort of problem often occurs if the speaker transformer primary winding goes open circuit, which removes the high tension (HT) from the plate of the output valve. The screen then tries to function as the plate and the valve is then often ruined due to excessive power dissipation in the screen circuit.

Most of the inter-coupling capacitors are polyester types so I didn't expect any problems with these. In fact, it was unlikely that there would be any major problems in the early stages at least, as nothing looked or tested faulty with the power off.

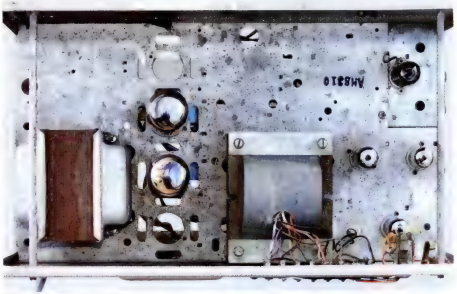
The output stage was a different story though, due to the badly-burnt resistors in the output valve screen circuits. To troubleshoot this problem, I decided that it would be best to remove the output valves and check all the voltages and components around that stage with power applied.

Insulation checks

Before applying power, I first needed to confirm that it was safe to do so. I also needed to check and reform the electrolytic filter capacitors on the HT line. These checks involved using a high-voltage insulation tester to check for leakage between the mains wiring and chassis and between the HT line and chassis.

These checks proved satisfactory. The mains-to-chassis resistance exceeded 200MΩ, while the HT-to-chassis resistance was greater than 50kΩ.

With these checks complete (and the output valves removed), I applied power for a second or two then turned it off for a few seconds. This allowed me to check how quickly the voltage built up and decayed on the HT line. This step was then continuously



These above-chassis views show the simplicity of the layout. The two large vacant holes are for additional output valves, as used in the 100W version.

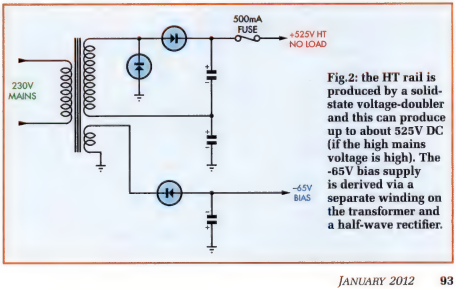


Fig.2: the HT rail is produced by a solid-state voltage-doubler and this can produce up to about 525V DC (if the high mains voltage is high). The -65V bias supply is derived via a separate winding on the transformer and a half-wave rectifier.

Silicon Chip Binders

These binders will protect your copies of SILICON CHIP. They feature heavy-board covers & are made from a distinctive 2-tone green vinyl. They hold 12 issues & will look great on your bookshelf.

★ 80mm internal width

★ SILICON CHIP logo printed in gold-coloured lettering on spine & cover

★ Buy five and get them postage free!

Price: $A14.95 plus $A10.00 p&p per order. Available only in Aust.

Silicon Chip Publications
PO Box 139
Collaroy Beach 2097

Or call (02) 9939 3295; or fax (02) 9939 2648 & quote your credit card number.

Use this handy form

Enclosed is my cheque/money order for

$_____ or please debit my

❑ Visa ❑ Mastercard

Card No:

_____

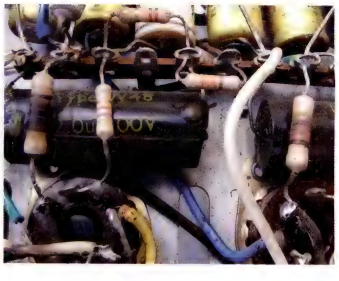
Card Expiry Date ____/____

Signature _____

Name _____

Address _____

_____ P/code_____



This view shows the two badly overheated resistors on the screens of the 7027A output valves. Fortunately, the cathode resistors had gone open circuit and saved the output valves from damage.

repeated for a couple of minutes to reform the electrolytic filter capacitors on the HT line.

If these capacitors charge quickly and then slowly discharge over a few seconds, it indicates that they have reformed correctly. In this case, it all worked out as expected so I reapplied power and checked the cathode voltages on the output valve sockets. They were both over +100V instead of the correct 0V, which wasn't good.

With the unit now disconnected from power, I checked the cathode resistors and found that they were both open circuit. In addition, both of the 2μF capacitors in the grid-to-cathode circuits were leaky, as were the 100nF coupling capacitors from the two 12AU7 valve plates to the respective grids.

Surprisingly, the screen resistors were still intact and measured 4.7kΩ and 5.6kΩ. In the end, I replaced all these resistors and capacitors. The original capacitors were paper and metallised-paper types and it was known that they eventually became leaky. In fact, it would have been better if AWA had used the more reliable polyester or polystyrene capacitors in this section of the amplifier, just as they had done in the front-end.

The other burnt resistor was in the feedback network and this was also replaced. The set was then wired on the speaker patch panel for a 12Ω line, to match my triple-cone test speaker. That done, I applied power to the set and adjusted the bias potentiometers to give about -50V at each grid pin.

The smoke test

It was now time to find out if the output valves had survived the rough treatment meted out by the faulty components. As a result, these valves were reinstalled and the power applied. The bias voltages remained roughly the same as before and both valves were drawing some current, determined by checking the voltage drop between each cathode and chassis.

At this point, I adjusted the bias pots until I had 16V between the cathodes and chassis. The fixed bias was now around -37V, which meant that the total bias was about -53V with respect to chassis.

The current drawn by each valve under these conditions is 32mA, which means that the dissipation in each valve is around 16W. This is well within the 35W plate dissipation rating for the 7027A valves. I don't know what cathode current AWA intended these valves to draw with no signal but 32mA and 16W dissipation seem to be safe values and the distortion in the output was low.

It's strange that the bias adjustments are hidden behind a plate on the rear. After all, it's also necessary to remove the cover under the chassis to gain access to the valve cathodes in order to measure the bias voltages. Surely it would have been more convenient to mount the bias adjustment pots adjacent to each cathode circuit?

Getting back to the restoration, the pots were all given a spray with Inox contact cleaner/lubricant to eliminate noise. The valve sockets were all in good order and did not require lubrication.

Once all that work had been completed, the old PA amplifier worked as normal. Some of the valves are a little

noisy and there is a little induced hum but considering the gain of the amplifier, it really is quite acceptable. In this unit, the grid circuits are high impedance and these can be susceptible to induced hum from mains voltages.

Fortunately, it appears that the output valves suffered little in the way of damage and there's no point replacing them. They were probably saved from destruction by the 470Ω cathode resistors going open circuit.

It's probable that quite a few of these AWA PA1002 PA amplifiers were affected by leaky capacitors around the output stages. One website that I found has an under-chassis view of one of these amplifiers and the same resistors were burnt out in that unit as well!

Cleaning up

Like most PA amplifiers of the era, the PA1002 is housed in a steel cabinet painted a grey hammer-tone colour. The U-shaped cover on my unit had a number of marks on it, while the front and rear panels were relatively unmarked. The chassis itself is also far from pristine, with discolouration largely due to the ravages of oxidation on the plating.

I tried cleaning the chassis with a small paintbrush and a kerosene-soaked rag but there was little improvement in its appearance. It's quite typical of the deterioration that occurs with plating over time, especially in a slightly hostile environment.

The valves were relatively clean but I like them to look like new if possible. To achieve this, I first washed all the miniature valves in warm soapy water, taking care not to rub the type numbers off them. By contrast, the octal valves need to be cleaned more carefully; they cannot be immersed completely, otherwise water may get into the base and create electrical leakage paths.

For this reason, I only immerse the glass envelopes and not the bases of octal valves in the water and gently rub the envelopes with soapy water using my fingers. The valves are then rinsed in clean water and left to dry by either supporting them upside down (so water doesn't run into the bases) or by laying them on their sides.

By contrast, the miniature types are left to dry by standing them on their pins.

The U-shaped cover was restored by first sanding it down to remove any rust and discolouration in the paintwork. It was then given several light coats of a grey hammer-tone paint (called "Galmet") on the top and sides. It ended up looking as good as new.

The front and rear panels were tidied up by spraying them with Inox and then wiping away the excess. This removed most of the minor blemishes and these panels now look quite acceptable. I also sprayed and wiped the knobs and they came up looking like new.

Summary

The PA1002 is a well-built PA amplifier and is still capable of providing years of reliable service. The output stage is rather unusual but both it and the signal limiter stage work well. As expected, the cabinet is rather utilitarian but it's rugged and provides good protection for the internal parts.

My tests indicate that the PA1002 gives its rated output with little hum. The only thing that I can criticise is the use of those paper and metallised-paper capacitors around the output stage. As stated above, these eventually become leaky and cause serious problems. Of course, it's possible that polyester capacitors were unavailable in the values needed at that time, which is why the less-reliable paper types were used.

In my case, I was lucky that the cathode resistors had gone open circuit and saved the output valves from destruction. That said, the unit was easy to troubleshoot and restore and is a good performer. SC

The third overheated resistor was in the feedback network and was easy to spot.

All the faulty parts were in the push-pull audio output stage. They included five resistors and four capacitors.

SILICON CHIP REFERENCE BOOKSHOP

$65

PROGRAMMING and CUSTOMIZING THE PICAXE By David Lincoln (2nd Ed. 2011)

A great aid when wrestling with applications for the popular PICAXE series of microcontrollers. Works at beginner, intermediate and advanced levels. Every electronics class, school and library should have a copy, along with anyone who works with PICAXEs. See the review in April 2011 SILICON CHIP. 300 pages in paperback

SMALL SIGNAL AUDIO DESIGN

By Douglas Self – First Edition 2010

The latest from the Guru of audio. Explains audio concepts in easy-to-understand language with plenty of examples and reasoning. Inspiration for audio designers, superb background for audio enthusiasts and especially where it comes to component peculiarities and limitations. 558 pages in paperback Expensive? Yes. Value for money? YES! Highly recommended.

$88

PROGRAMMING 32-bit MICROCONTROLLERS IN C By Luci di Jasio (2008)

Subtitled Exploring the PIC32, a Microchip insider tells all on the newest, most powerful PIC ever! Condenses typical introductory "fluff" focusing instead on examples and exercises that show how to solve common, real-world design problems quickly. Includes handy checklists. FREE CD-ROM includes source code in C, the Microchip C30 compiler, and MPLAB SIM. 400 pages paperback.

$79

TV ACROSS AUSTRALIA

Edited by Kaz Bielecki – 4th Edition 2007

The Grey Army's "Bible"! Travelling around Australia? Want to know where to point the antenna? This has the channels, polarity and location of all analog television transmitters and translators from coast to coast. (Any digital TV services are usually co-sited). Plus coverage maps, analog tv transmitter data . . . for the first time, everything you need to know in the one place!

$39

$60

PIC IN PRACTICE by D W Smith. 2nd Edition - published 2006

Based on popular short courses on the PIC, for professionals, students and teachers. Can be used at a variety of levels. An ideal introduction to the world of microcontrollers. 255 pages in paperback.

PRACTICAL GUIDE TO SATELLITE TV

By Garry Cratt – Latest (7th) Edition 2008

Written in Australia, for Australian conditions by one of Australia's foremost satellite TV experts. If there is anything you wanted to know about setting up a satellite TV system, (including what you can't do!) it's sure to be covered in this 176-page paperback book.

$49

PIC MICROCONTROLLERS: know it all

Multiple authors

The best of subjects Newnes authors have written over the past few years, combined in a one-stop maxi reference. Covers introduction to PICs and their programming in Assembly, PICBASIC, MBASIC & C. More than 900 pages in paperback.

$83

NEWNES GUIDE TO TV & VIDEO TECHNOLOGY

By KF Ibrahim 4th Edition (Published 2007)

It's back! Now in a new edition provides a full and comprehensive coverage of video and television technology including HDTV and DVD. Starts with fundamentals so is ideal for students but covers in-depth technologies such as Blu-ray, DLP, Digital TV, etc so is also perfect for engineers. 600+ pages in paperback.

$49

$60

PIC MICROCONTROLLER –YOUR PERSONAL INTRODUCTORY COURSE

By John Morton 3rd edition 2005.

A unique and practical guide to getting up and running with the PIC. It assumes no knowledge of microcontrollers – ideal introduction for students, teachers, technicians and electronics enthusiasts. Revised 3rd edition focuses entirely on re-programmable flash PICs such as 16F54, 16F84 12F508 and 12F675. 226 pages in paperback.

RF CIRCUIT DESIGN

by Chris Bowick, Second Edition, 2008.

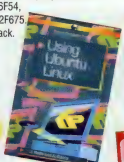
A new edition of the classic RF circuit design book. RF circuit design is now more important that ever in the wireless world in which we live. In most of the wireless devices that we use there is an RF component – this book tells how to design and integrate in a very practical fashion. 244 pages in paperback.

$63

USING UBUNTU LINUX

by J Rolfe & A Edney – published 2007

Ubuntu Linux is a free and easy-to-use operating system, a viable alternative to Windows and Mac OS. Introduces Ubuntu, tells how to set it up covers the various Open Office applications and gives troubleshooting hints and tips. Highly recommended. 222 pages in paperback



$27

OP AMPS FOR EVERYONE

By Carter & Mancini –NEW 3RD EDITION!

Substantially updates coverage for low-speed and high-speed applications, and provides step-by-step walk-throughs for design and selection of op amps. Huge 648 pages!

$100

$47.50

SOLAR SUCCESS – Getting it right every time by Collyn Rivers. 1st edition

The complete guide to home and property systems. Covers the ramifications of lighting, fridges and freezers, air conditioning, washing machines and driers and much more on solar systems; also covers solar basics and how to conduct an energy audit. As reviewed in SILICON CHIP November 2008. 112 pages.

10% OFF!

WANT TO SAVE 10%? SILICON CHIP (PRINT EDITION) SUBSCRIBERS* AUTOMATICALLY QUALIFY FOR A 10% DISCOUNT ON ALL BOOK PURCHASES!

(*Does not apply to website orders)

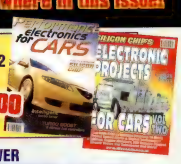
See the handy order form elsewhere in this issue!

WOW! WHAT AN OFFER!

SILICON CHIP'S PERFORMANCE ELECTRONICS FOR CARS AND SILICON CHIP'S ELECTRONIC PROJECTS FOR CARS Vol 2 – BOTH BOOKS TOGETHER AT A VERY SPECIAL PRICE!

Here's sensational value: PERFORMANCE ELECTRONICS FOR CARS (was $19.80) and ELECTRONIC PROJECTS FOR CARS VOL 2 (Originally $12.95) at a huge saving. While stocks last (they're getting low) and some might be slightly shop soiled – but just look at the saving! Get more performance, more projects for your car and $AVE!

$15.00



AC MACHINES

By Jim Lowe Published 2006

Applicable to Australian trades-level courses including NE10 AC Machines, NE12 Synchronous Machines and the AC part of NE30 Electric Motor Control and Protection. Covering polyphase induction motors, single-phase motors, synchronous machines and polyphase motor starting. 160 pages in paperback.

$66

DVD PLAYERS AND DRIVES

by K.F. Ibrahim. Published 2003.

A guide to DVD technology and applications, with particular focus on design issues and pitfalls, maintenance and repair. Ideal for engineers, technicians, students of consumer electronics and sales and installation staff. 319 pages in paperback.

As reviewed in Silicon Chip February 2004.

$71

PRACTICAL VARIABLE SPEED DRIVES AND POWER ELECTRONICS

by Malcolm Barnes. 1st Ed, Feb 2003.

An essential reference for engineers and anyone who wishes to design or use variable speed drives for induction motors. As reviewed in Silicon Chip September 2003. 288 pages.

$73

ELECTRIC MOTORS AND DRIVES

By Austin Hughes - Third edition 2006

Brand new edition of this amazingly popular book. Intended for non-specialist users of electric motors and drives, filling the gap between academic texts and general "handbooks". Explores all of the widely-used modern types of motor and drive including conventional & brushless DC, induction motors, steppers, servos, synchronous and reluctance. 384 pages, soft cover.

$51

SWITCHING POWER SUPPLIES A to Z

by Sanjaya Maniktala. Published 2006.

Theoretical and practical aspects of controlling and measuring electromagnetic interference in switching power supplies. Includes flow-charts for building DC-DC converters and their magnetic components under typical wide-input supply conditions. 503 pages in hard cover.

NEW EDITION DUE SHORTLY!

CD-ROM included.

RADIO, TV AND HOBBIES April 1939 to March 1965

– Every article to enjoy once again on DVD-ROM!

This remarkable archival collection spans nearly three decades of Australia's own "Radio and Hobbies"/"Radio TV and Hobbies". Every article has been scanned into PDF format – ready to read at your leisure on your computer (obviously, a computer DVD-ROM reader is required along with Acrobat Reader 6 or later). For history buffs, it's worth its weight in gold. For vintage radio enthusiasts, what could be better? For anyone interested in electronics, this is one which you MUST have in your collection! NB: Does not play on audio DVD players.

$62

AUDIO POWER AMPLIFIER DESIGN HANDBOOK

by Douglas Self NEW 5th Edition 2009

The latest edition of "the Bible" on audio power amplifiers. Many revisions and updates to the previous edition and now has an extra three chapters covering Class XD, Power Amp Input Systems and Input Processing and Auxiliarly Subsystems. Not cheap and not a book for the beginner but if you want the best reference on Audio Power Amps, you want this one!

483 pages in paperback.

$81

SELF ON AUDIO

by Douglas Self 2nd Edition 2006

A collection of 35 classic magazine articles offering a dependable methodology for designing audio power amplifiers in a way that improves performance at every point without significantly increasing cost. Includes compressors/limiters, hybrid bipolar/FET amps, electronic switching and more. 474 pages in paperback.

NEW LOW PRICE!

$69

PRACTICAL RF HANDBOOK

by Ian Hickman. 4th edition 2006

The latest guide to RF design for engineers, technicians, students and enthusiasts. Covers key topics in RF: analog design principles, transmission lines, couplers, transformers, amplifiers, oscillators, modulation, transmitters and receivers, propagation & antennas. 279 pages in paperback.

$61

BUILD YOUR OWN ELECTRIC MOTORCYCLE

by Carl Vogel. Published 2009.

Alternative fuel expert Carl Vogel gives you a hands-on guide with the latest technical information and easy-to-follow instructions for building a two-wheeled electric vehicle – from a streamlined scooter to a full-sized motorcycle. 384 pages in soft cover.

$40

THE AMATEUR SCIENTIST CD

Latest version – V4.

Many thousands of copies now sold. An incredible CD containing over 1000 classic projects, sourced from Scientific American over the past 73 years – covering every field of science. Very latest edition, just out. Suits ages 12 to adult and runs with any browser (on Win2000 or later). Recommended by the US National Science Teachers Assn.

$62

NOTE: ALL PRICES ARE PLUS P&P – AUSTRALIA ONLY: $10.00 per order; NZ – $12.00 PER BOOK; REST OF WORLD $18.00 PER BOOK

To Place Your Order:

eMAIL (24/7) silicon@siliconchip.com.au with order & credit card details

OR

FAX (24/7) Your order and card details to (02) 9939 2648 with all details

OR

PAYPAL (24/7) Use your PayPal account silicon@siliconchip.com.au

OR

PHONE - (9-5, Mon-Fri) Call (02) 9939 3295 with your credit card details

OR

MAIL Your order to PO Box 139 Collaroy NSW 2097

Or use the handy order form elsewhere in this issue

*ALL TITLES SUBJECT TO AVAILABILITY. PRICES VALID FOR MONTH OF MAGAZINE ISSUE ONLY. ALL PRICES INCLUDE GST

ASK SILICON CHIP

Got a technical problem? Can't understand a piece of jargon or some technical principle? Drop us a line and we'll answer your question. Write to: Ask Silicon Chip, PO Box 139, Collaroy Beach, NSW 2097 or send an email to silicon@siliconchip.com.au

Very low speed motor-control wanted

I have a couple of questions about the 10A Full-Wave Motor Speed Controller (SILICON CHIP, May 2009). Would it be able to smoothly control an electric drill spinning at between 10 and 20 RPM for between four and six hours and if so, would this cause any damage to the drill, like overheating the windings of the motor due to the switch-on current?

What I want to use it for is rotating a fishing rod in a cradle, via an adaptor in the chuck that is being built/repaired for a few hours so that the epoxy that is applied to the bindings around the guides does not sag. There are some demonstrations of how to achieve the speed control on YouTube but shall we say that they don't look all that safe. Or would I be better off using a DC cordless drill with a DC speed controller such as the high current variable frequency controller you published awhile ago.

There are specialist motors and rigs for this job available but the cost isn't worth it unless you are doing it professionally. (D. G., via email).

- The simplest approach would be to use a barbecue rotisserie motor. These are cheap, run at low speed all day and don't require a speed control. You can buy cheap 240VAC rotisserie motors on-line, at Bunnings or your local barbecue retailer.

Running an electric drill at low speed is impractical. It will overheat because its inbuilt fan is ineffective at low speed and produces no cooling. In any case, 10 RPM is extremely slow; it's only one revolution every six seconds.

It is also very doubtful whether a cordless DC drill could do the job for that length time. The rotisserie motor is the best and simplest solution.

High-frequency ferrite transformer query

I am investigating the possibility of having a variable output from a ferrite transformer working on a variable frequency to alter the voltage. The wattage has to be around 200W and the transformer has to be small.

One application I already know of in the work field is the inverter welders where the throughput is about 3600W and the transformer is only about a 60mm cube. The object of the exercise is to increase the frequency to obtain a higher voltage output and working around a frequency of about 5kHz. Can you help? (D. B., Warwick, Qld).

- We are not sure of the output voltage you require. We did publish a 200W 12V-to-240VAC inverter in February 1994. Its output voltage can be adjusted by altering the pulse width applied to the transformer. Altering the frequency does not alter the voltage.

Note that 5kHz is a relatively low frequency and ferrite transformers generally operate above 20kHz and up to 1MHz.

UHF remote control antenna problems

I would appreciate some information regarding the Deluxe 3-Channel UHF Rolling Code Remote (SILICON CHIP, July & August 2009). I have built the receiver, with two transmitters.

I am getting intermittently poor operation from both transmitters. I suspect the 433MHz receiver module. A CRO reveals continuous "digital looking" noise at the data output pin and pin 1 of the PIC, with or without the receiver antenna which changes as a transmitter operates. As I am aware of no nearby RF sources I would expect this pin to be quiet except when the transmitter is working.

Direct wiring between the transmitter PIC and the receiver PIC gives perfect operation. Is it likely the receiver module is faulty? On both remotes, I have tried a new UHF module and swapped PIC chips and re-registered with the receiver, noting the warning about distance, to no avail. The receiver acknowledge LED flashes but relay operation is intermittent.

I believe the noise is corrupting the data which the PIC interprets as an incorrect code. (I. S., Wollongong, NSW).

- It is normal for the receiver to continuously output noise or data. This is because the receiver has an automatic gain control that increases the gain when no signal is present. The output is then just noise. Upon reception of a

Ultrasonic Anti-Fouling & Foam-Core Hulls

I plan to build the Ultrasonic Anti-fouling Unit (SILICON CHIP, September & November 2010) and have a couple of questions regarding the unit's effectiveness when installed within a composite-hulled yacht consisting of a fibreglass inner skin, an Airex foam core and a fibreglass outer skin. I feel the foam core will isolate the ultrasonic vibration from the outside of the hull.

The other question relates to the sail drive which is bolted to the engine, both of which are insulated from the hull by rubber mounts and seals. I would appreciate your comments of the ultrasonic system in both of these situations. (S. W., South Townsville, Qld).

- We have answered variations of this question before but it is worth repeating. Unfortunately, the system will not work with foam-core or balsa core hull construction. Nor will it work with timber, timber sheathed with fibreglass or concrete hulls.

In yachts of conventional fibreglass construction, the ultrasonic anti-fouling would give some protection to the sail-drive by mere proximity.

Regrettably, until we devise a system to protect boats such as yours, we do not have an answer.

Phantom-Powered Microphones For Speaker Testing

I'm looking at using the True Audio "TrueRTA" audio spectrum analyser for DIY speaker building and testing (on a budget). The recommended microphone to use with this software is the Behringer ECM8000 electret condenser measurement microphone (or similar), which requires +15V to +48V DC (phantom powered) and a mic preamp to enable connection to a PC/laptop sound card. With this in mind I have been reading the "High Performance Microphone Preamplifier" project article in September 2010.

My questions are these: can this project be modified to provide the necessary +15V to +48V phantom power? The two mics I am looking at have an impedance of 600Ω (Behringer) and 200Ω (Dayton EMM-6, my preferred alternative). Could these mics be powered from USB using some form of step-up DC-DC converter? If so what type of step-up circuit would you suggest? (M. R., via email).

● You can modify the High Performance Microphone Preamplifier to suit the Behringer ECM8000 as follows. Omit the 2-pin header for microphone bias and instead solder a wire from its rectangular pad to the DC input socket pad which is closest to the centre of the board. Also, change the two 10kΩ resistors connecting the bias pin header to the microphone input socket to 6.8kΩ.

If you then power the preamplifier from a DC plugpack of 15-24V, that should provide sufficient power for the Behringer ECM8000. It is possible that 6.8kΩ is still too high a value but without more information on the current requirements for the microphone, it's hard to say (we couldn't find such information on Behringer's website).

As an alternative approach, you might like to check our review of the TrueRTA system (SILICON CHIP, September 2011). In that review, we suggested using our USB Recording Interface, featured in the June 2010 issue. Furthermore, we published a Circuit Notebook item on adapting the USB interface to phantom power in the September 2011 issue.

Incidentally, the Dayton EMM-6 microphone was specifically mentioned in the DIY loudspeaker measurements article in the December 2011 issue.

signal, the AGC alters the gain for best reception and the output is the data stream from the transmitter.

Poor operation from the transmitters is possibly an antenna problem. Make sure that both the antenna wire link and the coiled antenna wires are included on each transmitter and that each coiled antenna wire is the correct length (138mm) before spiralling. Make sure also that the spiralled wire ends are stripped of insulation before soldering the antenna in place. The receiver antenna must also be the correct length (157mm) and the enamel insulation must be stripped from each end before soldering it to the PCB.

Can the Rev Limiter cause a random spark?

I have been reading the Rev Limiter project article by John Clarke (SILICON CHIP, April 1999). I understand almost all of the project except one part. My question is: when the rev limiter shorts out the points or ignition transistor, how does it not create a random spark when it releases the short? If it does create a spark, how is this timed correctly to avoid damage to the engine?

If you could help me understand how this works I would be most grateful. (G. J., via email).

● That's an interesting question and in answering it we need to consider two points.

First, a spark can only be produced if there is sufficient current flowing through the coil at the time the Rev Limiter removes the short across the points or the ignition switching transistor. At the same time, a spark can only be produced if the points or ignition switching transistor happens to be open. If the points are closed, no spark will be produced until they open again and that will be a safe condition for the engine because that is when the spark should have been produced.

If a spark is produced (when the points are open) when a cylinder is on the compression stroke, the resulting mixture firing will have exactly the same effect as a one-off pre-ignition. Since pre-ignition can happen at any time with an engine under load, it is unlikely to cause any damage. On the other hand, if a random spark occurs at any other time in the engine cycle (eg, firing stroke, exhaust or inlet), no cylinder combustion can occur.

In fact, if you consider the double-ended ignition coils used in Holden Commodores, they do produce weak sparks in non-firing cylinders (ie, when there is no fuel mixture to burn) and this is completely harmless.

Speed Alert may not need magnets

I just got your Speed Alert kit from Jaycar and was surprised to discover that I would need to hang magnets and a pickup coil on the drive-shaft to trigger the unit. Is it not possible to use the existing speedo pulse generator already installed on the gearbox? (N. G., via email).

● The Speed Alert was published back in November and December 1999 and so this is why it used magnets and a coil for the speed pickup, as most cars used a mechanical speedometer cable at that time. Modern cars can be connected to the speed alert without using the magnets and coil, by connecting the car's speedometer signal to the signal connection input (not the earthed connection) on the shielded cable. The earthed braid is left unconnected at the speedometer signal end.

And while you have purchased the kit, we should note that most car GPS units have a speed alarm facility and it has the virtue that it automatically changes the speed alarm setting to suit the road you are travelling on. The facility is not foolproof however as the GPS will often not "know" about recent speed limit changes.

Regulator connection for GPS module

I'm trying to power a GPS module with 3.3V in a circuit very similar to your GPS Clock driver of June 2009. My problem is that fitting the 317 regulator as described yields an out-

Substituting Triacs In The Digital Lighting Controller

I am currently in the process of building the Digital Lighting Controller (SILICON CHIP, October to December 2010), together with some slave units.

I have a question with regard to the Triacs. The article warns against substituting other Triacs for the BTA41s specified. I have a box of SC151Ds that I would like to use. The only significant differences that I can see are that the SC151Ds have a lower continuous and peak current rating and they do not have an isolated tab. The lack of an isolated tab does not seem to be a problem electrically, as the tab is internally connected to T2 (or A2) terminal. In this circuit these are all connected to the Active line anyway.

Of course, this means that the heatsinks will all now be at full mains potential and pose a safety hazard. I intend to house my slave(s) in an earthed and secure metal box. I have used SC151Ds in the past for 240VAC mains switching. I have even used AC06DRs and AC10DRs – but that was a long while ago! I am fairly sure that, like the SC151Ds, they were 400V-rated.

I blew quite a few ACxxDRs in their day but assumed it was for excessive (peak) current reasons. I had found the SC151Ds a bit better but once again, maybe their loss was due to sailing a bit too close to the voltage limits rather than current. Are there any more issues with regard to using the SC151Ds that I have not considered? (G. S., via email).

● As we say in the article, we specify the BTA41s (rated at 600V, 40A) because when PAR (parabolic reflector) lamps fail, the resulting surge current can be very high and we don't want this to blow the Triac.

You can use a Triac with a lower current rating if you are sure that your load will not exceed it, even during momentary fault conditions. You can get away with 400V Triacs most of the time but there are inevitably mains spikes and with the availability of 500V and 600V models (which don't usually cost much more), it seems like a risk that isn't worth taking.

As for the non-isolated tabs, if used to control mains this would definitely make the board more of a shock hazard. An earthed metal box should render it safe enough. Just make sure you don't operate it with the box open.

The final remaining issue for substituting Triacs is the gate sensitivity but this should not be a problem since the SC151 series are at least as sensitive as the BTA41 (50/80mA maximum trigger current, compared to 50/100mA for the BTA41).

put voltage that's nearly fixed despite varying the trimpot and very variable as I alter the input voltage.

In other words, the 317T regulator is working opposite to its design. Four different chips perform in the same manner, so I assume it's my circuit but I cannot see what I'm doing wrong. (D. M., via email).

● The LM317T connections shown in our circuit on page 37 of the June 2009 issue are correct but perhaps you may not have noticed that the regulator is drawn with the power flow from right to left in that circuit. The voltage divider which allows the LM317T to monitor the output voltage connects to the output pin as normal, except that in the circuit the output pin is shown on the lefthand side.

From your symptoms we wonder if you have either inadvertently connected the top of the divider to the input pin, or perhaps connected the protective diode (D4 in our circuit) the wrong way around, so it is "bypassing" the regulator anyway.

Pool sanitisers don't work

Have you considered a project to create a DIY swimming pool sanitiser of the type that is installed in-line and releases copper and silver ions into the water? This removes the need for most if not all chlorine and also isocyanuric acid, both of which are very harmful chemicals.

Commercial ionisation products "seem" relatively basic and yet expensive. Similarly, possible projects for ozone generation which can possibly be used in tandem with ionisation to give oxidation of organic matter and sanitation with minimal chemical requirement. I would love to see this kit. (B. C, via email).

● We don't have any plans to do such a project and with good reason. They don't work. Here is what the Australian Pesticides and Veterinary Medicines Authority (APVMA) says about silver and copper ion sanitisers for pools:

"Chemical pool sanitisers fall into the category of chemical pesticides and are regulated at the Federal level by the APVMA. Although the name of the APVMA refers to Agricultural Pesticides, the APVMA still has jurisdiction over swimming and spa pool sanitisers as well as certain other kinds of chemical sanitiser products. There are a large number of registered pool sanitiser products most of which are based on chlorine or bromine. The majority of these were registered under State and Territory registration systems prior to the establishment of the APVMA. These products are based on levels of free chlorine or bromine that meet current standards and are therefore effective when used according to instructions.

The Australian Pesticides and Veterinary Medicines Authority (APVMA) took action in 2004 against a number of companies that were marketing products advertised as sanitisers for swimming and spa pools. These sanitiser products were said to act by releasing silver ions or copper and silver ions together into pool water. The metal ion based systems were promoted in most cases as sanitation systems superior to chlorine. The majority were promoted as alternatives to chlorine, and non-chlorine oxidisers such as potassium monopersulphate were recommended for use with them. A few of the products did recommend use of chlorine but at levels substantially below the recommended minimum level of 1 ppm for swimming pools and 2 ppm for spa pools (See Australian Standards 3633 and 2610).

The metal ion based products against which the APVMA took action were not registered with the APVMA and had not been assessed according to scientific standards for safety or efficacy. The APVMA did not have reliable evidence that these products worked effectively to protect the health of pool users. Importantly, the APVMA had scientific informa-

Next Month In Silicon Chip: February 2012

Vertical Farms

Combining hydroponics, LED illumination and computer control of all nutrients, this Australian development could be the basis for factory farming in the future. It has very fast turnaround from planting to harvest and such "factories" can be based right in the cities where fresh produce is sold. Alternatively, they can be placed in remote communities where fresh produce is often expensive and difficult to obtain.

How to control a Fischer & Paykel SmartDrive Motor

There have been plenty of articles on how to use these direct-drive washing motors as generators in windmills and other applications but never an article on how to use them as a motor! It turns out to be quite tricky as they normally employ all the electronics in the washing machine. This article will give you the low-down on wiring the motor to run from lower supply voltages.

Discrete Semiconductor Test Set

How many discrete semis have you got in your collection? Hundreds? Thousands? Are they all good? You don't know, do you? With our new Discrete Semiconductor Test Set you will be able to test a wide range of active components: LEDs, Diodes (including zeners and Schottkys), Bipolar Junction Transistors, Mosfets, SCRs and Programmable Unijunction Transistors (PUTs), for gain (where applicable), voltage breakdown and leakage. It uses a ZIF socket to cope with a wide range of devices and has an LCD panel to display test results. Pt.1 in February describes all the different test modes.

Crystal DAC

For the very best performance from 24-bit/96kHz recordings, this new board uses the Crystal CS4398 DAC and a discrete transistor output stage. It can be dropped into our original Stereo DAC project without any major changes, replacing the Burr-Brown DSD1796 DAC IC with the high-end Cirrus Crystal CS4398. Its harmonic and intermodulation distortion figures are significantly lower than before and surprise, surprise, the differences can be discerned. Try it and find out for yourself.

Simple 1.5A Switching Regulator

This small switching regulator can deliver anywhere from 1.2-20V at up to 1.5A. It runs at 500kHz at up to 90% efficiency, with very low dropout voltage, little heat generation and electronic shutdown. Apart from that, it has low quiescent current (3mA) and only 10µA when shut down. How could you resist building it?

Note: these features are prepared or are in preparation for publication and barring unforeseen circumstances, will be in the February issue.

ON-SALE: Wednesday, 25th January 2012

tion that called the efficacy of these products into question. This raised serious concern about these products because micro-organisms transmitted to bathers through pool water can be very dangerous and even deadly.

The following information provides explanation about why the APVMA moved to require warnings with these products and require scientific evidence that these products are safe and effective. The references discussed below are not intended to be comprehensive and are supplied as examples of the information considered by the APVMA."

For the remaining part of this article, see: **www.apvma.gov.au/use_safely/pool/background.php**

Hearing loop receiver is motor-boating

I'm having a few problems with a Hearing Loop Receiver (Silicon Chip, September 2010) built from a Jaycar kit. All I can hear on phones is a continuous pop-pop-pop oscillation, with level controlled by the pot, but there is no pickup at all on a known working hearing loop.

I've rechecked my construction, particularly looking for dry solder joints and solder bridges. All components appear to be as specified and all are inserted correctly. But it can't be so! Does my scant description suggest any clues which I should follow up? (B. G., Mt. Waverley, Vic).

- The circuit appears to be motor-boating and this is a form of oscillation, only at a slow rate. It is possibly caused by a capacitor that is not bypassing the supply. The 150Ω resistor in the positive supply rail supplying op amp IC1 is there to isolate the supply from the power amplifier (IC2). The 470µF capacitor for IC1's supply decouples this supply rail. Check or replace the 470µF capacitor located just above IC1 on the PCB.

Another possible cause of motor-boating is that inductor L1 is not connected or has a broken internal connection. Check that there is continuity between the two leads of the inductor.

The best motor for a rotisserie

I am trying to use an electric motor from an old washing machine to make a rotisserie and I realise the speed would have to be controlled. Would the 230VAC 10A Full-Wave Motor Speed Controller (Silicon Chip, May 2009) be suitable for my purpose? Is it all I need, with the motor bolted to a frame and connected to the spit rod? (T. N., Alice Springs, N. T.)

- Your washing machine motor is likely to be an induction type and as we have noted many times before, these cannot be controlled by any speed controller which merely varies the voltage. The motor speed is locked to the 50Hz mains frequency and therefore the only way you can vary

Notes & Errata

Hearing Loop Signal Conditioner (January 2011): IC4 should be an SA571 compandor chip, not an SAA571 as shown on the circuit, overlay and parts list.

Digital Audio Delay (December 2011): the overlay diagram (Fig.6) is missing a copper fill under TX1, RX1, S1 and CON2, connecting the ground pins together. The PDF file on the SILICON CHIP website and the files provided to kitset makers do not have this problem.

G-Force Meter (November 2011): the overlay diagram (Fig.2) incorrectly shows IC2 as a PIC18LF13K22. It should be a PIC18LF14K22, as on the circuit diagram.

SD Card Music & Speech Recorder/Player (August 2009); Web Server In A Box (Nov 2009-Jan 2010); Universal USB Data Logger (Dec 2010-Feb 2011); Quizzical (October 2011): the Jaycar PS0024 memory card socket used in these projects has been discontinued and is no longer available. There is no equivalent so we have updated the PCBs for the above projects to suit the Altronics P5722 memory card socket.

Note that this socket has a metal shield so if the PCB does not have a solder mask, it will be necessary to place a thin plastic insulator under the socket.

We have not tested it but the Amphenol 10100708 socket appears to have the same footprint.

the speed is to vary the frequency of the AC supply.

As stated elsewhere (page 98), running an electric drill at low speeds is also not a practical proposition. The speed is simply too low and even if you did have an induction motor speed controller, you would also need a reduction gearbox to get the really low speed required.

Hence, our answer is the same as before: get a rotisserie motor. These are readily available from Bunnings and barbecue centres. You can buy cheap ones for small loads or more expensive ones if you plan to cook a pig or other large animal carcase.

Mind you, it might be easier to do it the Pacific Islander way: hot stones, banana leaves on top off the carcase and a layer of sand on top – tastes good!

Customising the Speedo Corrector

I have bought and assembled several Speedo Corrector kits (SILICON CHIP, December 2006). In all cases I have fitted them to Ford Falcons. I always leave link 3 and link 1 in place. After setting to "A" and "2", the pulse type is read.

What components can I leave out of the circuit so that it will still function for my needs? I don't need the A/C output or the pull-down function. I also don't need the "slow" option. Is it possible to bridge the circuit anywhere so it always runs fast? (or is this inbuilt in the PIC). (D. A., via email).

- Transistor Q6, its associated 10kΩ base resistor, the 470Ω collector resistor, the 100µF capacitor at Q6's collector and the 10kΩ resistor to ground for the capacitor can all be deleted. The LK4 and LK5 headers can also be omitted.

We do not know what setting the PIC provides for the Falcon in the automatic set-up. You can check after the automatic set-up has run if transistor Q3 is switched on (there will be a high of about 5V at the RA2 output of IC1) or if Q2 is on with a high at the RA3 output. If RA2 is high leave Q3 and Q4 in place and the associated resistors. If RA3 is high leave Q2 in place and its associated base and emitter resistors.

The transistors controlled by a low RA2 or RA3 output can be removed, including the associated base and collector resistors.

It is not possible with the current design to add a digital display to show the percentage change setting.

The fast/slow setting is an option that needs to be selected. The design was to allow for all possible (hopefully) variations that constructors may require in order for the Speedo Corrector to operate in all vehicles. Unfortunately, that makes it tedious for constructors who build many of these units for a particular vehicle and who know the required set-up.

The automatic set-up does not have to be run if the settings are known. The known correct settings can be set using the B, C, D, E and F positions on switch S2 instead of using the automatic (A) setting and running the vehicle.

Amplifier with AVC wanted

Have you ever published an article on a small audio amplifier, say 1-2W, that would take the earphone output

. . . continued on page 104

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely.

Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine.

Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

Advertisers are warned that they are responsible for the content of all advertisements and that they must conform to the Competition & Consumer Act 2010 or as subsequently amended and to any governmental regulations which are applicable.

MARKET CENTRE

Cash in your surplus gear. Advertise it here in SILICON CHIP

ELNEC IC PROGRAMMERS

High quality
Realistic prices
Free software updates
Large range of adaptors
Windows 95/98/Me/NT/2k/XP

CLEVERSCOPE USB OSCILLOSCOPES

2 x 100MSa/s 10bit inputs + trigger
100MHz bandwidth
8 x digital inputs
4M samples/input
Sig-gen + spectrum analyser
Windows 98/Me/NT/2k/XP

IMAGECRAFT C COMPILERS

ANSI C compilers, Windows IDE
AVR, TMS430, ARM7/ARM9
68HC08, 68HC11, 68HC12

GRANTRONICS PTY LTD

www.grantronics.com.au

SPLat CONTROLS Tough times demand innovative solutions!

In tough economic times you need to watch every dollar. SPLat embedded controllers give OEMs more functionality per dollar than any competing product. Check out our website today and discover how we can help you remain competitive.

Made in Australia, used by OEMs world-wide

splat-sc.com

Printed Circuit Board Manufacture

48-Hour service • High quality • Low prices
1 offs to any quantity
Artwork design if required
Call for obligation free quote...
INSTANT PCBs, POBox 448, Avalon 2107
Ph (02)9974 1189 Fax (02)9974 5491

Issues Getting Dog-Eared?

Keep your copies safe with these handy binders

Price: $A14.95 plus $10.00 p&p per order (incl. GST). Buy five & get them postage free! Fill in and mail the order form in this issue or phone (02) 9939 3295 and quote your credit card number. Available Aust. only.

Battery Packs & Chargers

Siomar Battery Engineering
www.batterybook.com
Phone (08) 9302 5444

FOR SALE

LEDs! Nichia, Cree and other brand name LEDs at excellent prices. LED drivers, including ultra-reliable linear driver options. Many other interesting and hard-to-find electronic items! **www.ledsales.com.au**

PCBs & Micros: Silicon Chip Publications can supply PCBs and programmed micros for recent (and some not so recent) projects described in the magazine. See our advert in this issue for further details. Phone (02) 9939 3295 or email **silicon@siliconchip.com.au**

questronix.com.au – audiovisual experts solve home, corporate security and devotional installation & editing woes. QuestAV CYP, Kramer TVone (02) 4343 1970 or **sales@questronix.com.au**

PCBs MADE, ONE OR MANY. Any format, hobbyists welcome. Sesame Electronics Phone (02) 8068 2713. **sesame@sesame.com.au www.sesame.com.au**

MAXIMITE BREAKOUT BOARD: 10 channels, 2 relays per board. 2 boards can be cascaded to get all 20 channels. Each channel can be configured as Digital In, Digital Out or Analog In, screw terminals. More information **www.hamfield.com.au**

WANTED

WANTED: EARLY HIFIs, AMPLIFIERS, Speakers, Turntables, Valves, Books, Quad, Leak, Pye, Lowther, Ortofon, SME, Western Electric, Altec, Marantz, McIntosh, Tannoy, Goodmans, Wharfedale, radio and wireless. Collector/Hobbyist will pay cash. (07) 5471 1062. **johnmurt@highprofile.com.au**

CUSTOMERS WANTED: Truscotts Electronic World – large range of semiconductors and passive components for industry, hobbyist and amateur projects including Drew Diamond. 27 The Mall, South Croydon, Melbourne. Phone (03) 9723 3860. **www.electronicworld.com.au**

KIT ASSEMBLY & REPAIR

KEITH RIPPON KIT ASSEMBLY & REPAIR:
* Australia & New Zealand;
* Small production runs.

Phone Keith 0409 662 794. **keith.rippon@gmail.com**

GEOFF COPPA KIT ASSEMBLY AND TROUBLE SHOOTING SERVICE. Phone Geoff on 0414226102. **coppamitchell2@bigpond.com**

ADVERTISING IN MARKET CENTRE

Classified Ad Rates: $29.50 (incl. GST) for up to 20 words plus 85 cents for each additional word. Display ads: $54.50 (incl. GST) per column centimetre (max. 10cm). Closing date: 5 weeks prior to month of sale. To book, email the text to **silicon@siliconchip.com.au** and include your name, address & credit card details, or fax (02) 9939 2648, or phone (02) 9939 3295.

RFMA RF Modules Australia
Low Power Wireless Connectivity Specialists

USB BLUETOOTH
PARANI UD100-G01
Class 1 Bluetooth 2.0+EDR
Working distance to 300m
Toshiba or BlueSoleil driver
Optional 5dBi Dipole Antenna

Applications:
Rural
Utilities
Industrial
Commercial
Government
Meter Reading

CONNECT TO YOUR SOLAR INVERTER THE EASY WAY!

RF Modules Australia. P.O. Box 1957 Launceston, TAS., 7250.
Ph: 03-6331-6789. Email: sales@rfmodules.com.au. Web: rfmodules.com.au

Circuit Ideas Wanted

Do you have a good circuit idea? If so, sketch it out, write a brief description of its operation & send it to us.
Provided your idea is workable & original, we'll publish it in Circuit Notebook & you'll make some money. We pay up to $100 for a good circuit so send your idea to:
Silicon Chip Publications, PO Box 139, Collaroy, NSW 2097.

DOWNLOAD OUR CATALOG AT
www.iinet.net.au/~worcom
WORLDWIDE ELECTRONIC COMPONENTS
PO Box 631, Hillarys, WA 6923
Ph: (08) 9307 7305 Fax: (08) 9307 7309
Email: worcom@iinet.net.au

MEAN WELL Power Supplies On The Net
www.radioandelectronics.com
Ph: 1300 495 211 Fax 08 9402 1287
Email: sales@radioandelectronics.com
PO Box 780, Hillarys, WA 6923

Ask SILICON CHIP

. . . continued from p102

of a radio scanner but with an effective AVC (automatic volume control) action to smooth out the varying levels associated with such receivers? Treble boost would also be necessary. (P. M., via email).

● No, but the Hearing Loop Signal Conditioner from our January 2011 issue can be used. This is a mono line signal conditioner with treble boost and an automatic volume control. In addition, an amplifier would be needed to drive a loudspeaker.

You could use the stereo amplifier from the May 2010 issue (Jaycar KC5495) or the Champ from February 1994 (Jaycar KC5152).

Solution for a motorcycle ignition

I have a 1982 Honda CX500 motorcycle with a failing ignition system. As usual, the problem is not the CDI but the high-voltage source coil which is wound on the alternator stator and very expensive to replace. The coils fail due to excessive heat and no cooling. As the CDI is sound I thought it would be possible to build a solid-state high-voltage source such as the high voltage section of the "Multi-Spark Capacitor Discharge Ignition" kit (SILICON CHIP, September 1997).

The only problem I can see is that the kit high-voltage section supplies 300V whereas the bike CDI SCR circuit only requires 100V DC. Do you think it would be possible for me to convert the high-voltage section of the kit to 100V instead of 300V? If it is possible, I know the information will help many owners of older bikes whose only problem with failing ignition is faulty and very expensive to replace source coils. (J. J., via email).

● The high-voltage section of the Multi-Spark Ignition is not suited to connect to a motorbike CDI. They effectively short out the high voltage when firing.

The high-voltage coil could be rewound instead of replaced. Motor rewinders or transformer manufacturers can do the job. Alternatively, you can do the rewind yourself as the winding wire can be purchased and the coil rewound in the same way as the original winding. SC

Advertising Index

Altronics 80-83
Australian Robotics 19
Clarke & Severn Electronics 43
Element14 23
Emona Instruments 45
Geoff Coppa 103
Grantronics 103
Hare & Forbes ..... OBC
High Profile Communications 103
HK Wentworth 13
Instant PCBs 103
Jaycar IFC,49-56
Jimojo 42
Keith Rippon 103
Kitstop 42
LED Sales 103
LHP.NET.AU ..... IBC
Little Bird Electronics 17
Measurement Innovation 43
Microchip Technology 3
Microzed Computers 43
Mikroelectronika 11
Mouser Electronics 5
Ocean Controls 21
Prime Electronics 10
Quest Electronics 103
Radio & Electronics 104
RKT Auctioneers 95
RF Modules 104
RMS Parts 71
Rohde & Schwarz 22
Sesame Electronics 103
Silicon Chip Binders 94
Silicon Chip Bookshop 96-97
Silicon Chip Order Form 79
SC Performance Elect. For Cars 94
Silicon Chip PCBs 69,103
Silicon Chip Subscriptions 12
Siomar Battery Engineering 7,103
Splat Controls 103
Truscotts Electronic World 103
VAF Research 42
Wiltronics 9
Wireless Design 42
Worldwide Elect. Components 104

LHP (02) 9620 9011
LHP.NET.AU

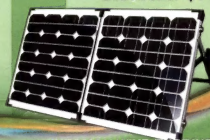
NON FOLDING
20W : $59
50W : $150
80W : $250
100W : $300
120W : $350
200W : $599

FOLDING
60W : $199
80W : $299
100W : $350
120W : $399
160W : $499
200W : $599

FREE DELIVERY

240VAC INFOMON PURE SINEWAVE SILENT INVERTER GENERATOR
2KVA: $499
3.5KVA: $799

LCD CHARGE CONTROLLER
30A: $89
50A: $150



$49
12V LED LIGHT STRIP
5m, cut and reuse, weather proof, adhesive back, various colours!
LED BAR LAMPS available with a magnetic back! $49

FRIDGE FREEZER FREE BONUSES: insulation cover, wall charger, & cigarette adaptor. **REDUCED!**
45L was $1499 NOW $499
80L was $1899 NOW $599

INFOMON WIND TURBINE
One of the most advanced wind turbines to generate some serious power, sold as a 1kW or 2kW complete kit with a stand and rectifier.
LIMITED STOCK!
1kW: $899 2kW: $1999

was $1250
NOW $499
125CC
was $1450
NOW $899

TOOLS CLEARANCE

22CC HEDGE TRIMMER: $99
52CC CHAINSAW: $99
SELF PROPELLED LAWN MOWER: $250
PRESSURE WASHER: $199

KITCHEN SALE

rangehood $199
4 burner gas cooktop $99
ceramic electric cooktop $299
stainless steel electric fan forced oven $299

REVERSING CAMERA KIT
Includes all connection cables, 7" monitor, remote & IR camera was $189 REDUCED TO (wireless kit: $199) **$99**

NEW GYM TREADMILL
- Auto incline
- Cardio programs
- Cup holder & safety key
- Commercial grade
- 2 years warranty

REDUCED TO $488

HEATED HYDRO THERAPY SPA
- Computer control touch pad (50+ jets)
- Complete with pumps, filtration system
- Radion heater + recliner head rests
- Available in modern white interior polish
- 100% AUSTRALIAN OWNED company
- 100% AUSTRALIAN APPROVED

WAS $8899

CLEARANCE SALE $3899

NEW THERAPEUTIC INFRARED SAUNA

WAS $2599 NOW ONLY $999

ONE'S HEALTH TRAMPOLINE
- Lock out safety net
- Double sided safety pad
- Strong reliable steel frame
- AUSTRALIAN APPROVED

12ft $299 16ft $399

ph: (02) 9620 9011

www.lhp.net.au

Happy New Year! 2012

DRILLING MACHINES

- 1HP 240V motor
- 16-speed
- 16mm drill capacity
- 170mm throat depth

FREE VICE (K126)

BENCH MODEL $269 (D136)

PEDESTAL MODEL $299 (D142)

TOOL CHEST & ROLLER CABINET

6 Drawer Tool Chest $99 (T690)
- Lockable by key
- Ball bearing slides

5 Drawer Roller Cabinet $198 (T695)
- Lockable by key
- Ball bearing slides

PACKAGE PRICE ONLY $269 (K004)

AIR COMPRESSOR

- 2.5hp 240V motor 36 litre tank
- Free air delivery 134 litres/min
- Vertical pump design

$220 (C326)

FREE ACCESSORY KIT (K005)
- Spray gun & pot
- Degreasing gun
- Tyre inflator with gauge
- Dusting gun with self coil hose

$396 (A384)

HEAVY DUTY WORK BENCH with BACKING PANEL

- Heavy duty steel construction
- 2 huge adjustable shelves
- Solid 38mm thick timber top
- Sturdy steel pegboard backing panel
- 5 drawers with smooth ball bearing slides
- Dimensions (LxWxH): 137 x 51 x 157cm
- Quality industrial finish
- 890mm table height
- Weight (nett) 86kg

WORK STATION SOLUTION

* Shown with optional buckets & hooks

TAP & DIE SET 32 PIECE

- Range: M3 - M12

32 PIECE

Carbon Steel $49 (T012)

HSS $109 (T013)

BURR SET - 5 piece

- Solid carbide burr
- SD-3, SE-3, SA-3, SC-3, SF-5
- 3/8" & 1/2" head sizes
- Double cut burrs
- 1/4" shanks

$79 (B900)

HAND SHEARS

4mm shear 150mm blade $89 (S186)

6mm shear 300mm blade $139 (S188)

OPTIONAL STORAGE TRAYS

105 x 110 x 50mm	$3.00	(A430)
105 x 140 x 75mm	$4.00	(A432)
140 x 220 x 125mm	$9.00	(A434)
140 x 270 x 125mm	$12.00	(A436)

OPTIONAL HOOKS

Double Prong Hook - 40mm wide	$2.50	(A391)
Single Hook - 50mm wide	$2.50	(A392)
Screw Driver Hook - 270mm wide	$6.00	(A393)
Rack for Buckets Hook - 440mm wide	$4.00	(A394)

ORDER NOW!

USE PROMO CODE: CHIPTRONIC TO RECEIVE THESE SPECIAL PRICES ONLINE OR INSTORE!

WORKSHOP DRILL SET

- 170 piece 1-10mm

$159 (D126)

DRILL SETS

- High-speed steel - Tinite coated
- Supplied in metal case

25 Pce Metric 1-13mm $35 (D120)

29 Pce Imperial 1/16"-1/2" $35 (D121)

DRILL SHARPENER

- Economy drill bit sharpener with split point feature
- 80W 4200rpm 240V DC motor
- Range 3-13mm

$109 (D070)

THREAD REPAIR KIT

- Metric (5,6,8,10,12mm)

$149 (T100)

DEBURRING TOOL

- Includes 10 x HSS blades
- Ergonomically designed
- Has thumb rest
- Grips well in hand
- Telescopic holder
- Blades can be stored from the back side

$29 (C050)

HARDWARE ASSORTMENT PACKS

No.	Assortment	CODE	Price
01	106 Piece Hex Cap Screw	K72024	$15
02	224 Piece Stainless Steel Nut & Bolt	K72062	$25
03	141 Piece Sealing Washer	K72090	$15
04	42 Piece Hose Clamp	K72146	$15
05	225 Piece Metric Metric O-Ring	K72168	$15
06	225 Piece Imperial (SAE) Nitrile O-Ring	K72169	$15
07	120 Piece Roll Pin	K72204	$15
08	60 Piece Metric Key Stock	K72310	$15
09	60 Piece Imperial (SAE) Key Stock	K72312	$15
10	80 Piece Woodruff Key	K72316	$15
11	150 Piece Nylon Lock Nut	K72450	$15
12	790 Flat & Spring Washer	K72116	$15
13	175 Spring & Hitch Pin	K72712	$15
14	50 Piece Lynch Pin	K74122	$25
15	382 Piece Imperial (SAE) O-Ring	K74146	$25
16	397 Piece Metric O-Ring	K74150	$25
17	50 Piece Hydraulic Grease Fittings	K74234	$15
18	363 Piece Machine Screw	K74358	$25
19	300 Piece External Snap Ring	K74378	$15
20	300 Piece Internal Snap Ring	K74394	$15
21	150 Piece Set Screw	K74444	$15
22	125 Piece Grommet	K74702	$15

BoxTac®

ENGINEERS FILE SET Second Cut - 200mm

- Cushion grip handles
- Flat, round, 1/2 round, square & triangular

$29 (F100)

ENGINEERS FILES

- Cushion grip handle
- 250mm length files

TYPE	GRADE	PRICE	Code
Flat	Second Cut	$12	(F121)
Flat	Smooth	$12	(F122)
Half Round	Coarse	$12	(F124)
Half Round	Second Cut	$12	(F125)
Half Round	Smooth	$12	(F126)
Round	Coarse	$12	(F127)
Round	Second Cut	$12	(F128)
Round	Smooth	$12	(F129)

COMBINATION DRILL & TAP SET

- HSS M2 Bright Finish
- Hex Shank
- M3, M4, M5, M6, M8, M10
- Includes Hex snap-on for hand drill

$44 (T0191)

INDUSTRIAL STEP DRILLS

- Suitable for sheetmetal
- Industrial quality
- HSS M2 bright finish
- Sizes: 4-12 x 1mm 6-20 x 2mm 6-30 x 2mm

$70 (D1071)

Specifications & Prices are subject to change without notification. All prices include GST and valid until 29-02-12

HARE&FORBES MACHINERYHOUSE

NSW	QLD	VIC	WA
(02) 9890 9111	(07) 3274 4222	(03) 9212 4422	(08) 9373 9999
1/2 Windsor Rd, Northmead	626 Boundary Rd, Coopers Plains	1 Fowler Rd, Dandenong	41-43 Abernethy Rd, Belmont

www.machineryhouse.com.au

MJSC-0901/12